University of Minnesota

Traffic Simulation Study

Washington Avenue Corridor

BRW Inc.

March 12, 1997
Revised: July 17, 1997

Memorandum

BRW

B R W INC.

Planning
Transportation
Engineering
Urban Design

Thresher Square
700 Third Street So.
Minneapolis,
MN 55415
612/370-0700
Fax 612/370-1378

Denver
Milwaukee
Minneapolis
Newark
Orlando
Phoenix
Portland
San Diego
Seattle

DATE: July 18, 1997

TO: Mr. Bob Baker
University of Minnesota
Parking Services

FROM: Howard Preston, PE
Bob Green, PE

SUBJECT: Washington Avenue Corridor
Traffic Simulation Study
Final Revisions and Recommendations

This memorandum documents the results of the analysis conducted to address several issues resulting from a draft review meeting held on April 8, 1997. The meeting included University, City of Minneapolis, Hennepin County, and BRW staff and was held to review the draft report, "University of Minnesota Traffic Simulation Study, Washington Avenue Corridor", BRW, Inc., March 12, 1997.

The following issues were identified for further analysis in order to complete the Washington Avenue Corridor Study.

1. Analyze the impact of a pedestrian scramble phase on traffic operations.

2. Analyze the impact of adding a northbound right-turn lane on Church Street and providing access to the new Coffman Memorial Union Ramp from Church Street.

3. Document the accident history for Washington Avenue.

4. Review the design guidelines to determine if the shoulders provided under the three lane alternative could be considered bike lanes.

5. Under the three lane alternative, increase the cycle length and revise the signal timing splits and offsets to determine the effect on traffic operations.

This memorandum presents the overall recommendations based on the results of the study, followed by a discussion of the issues listed above.

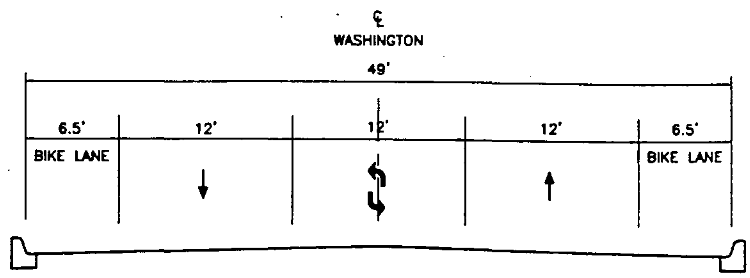
RECOMMENDATIONS

Based on the technical analysis contained in this report, the improvements listed below and shown in Figure A-1 should be considered by University staff:

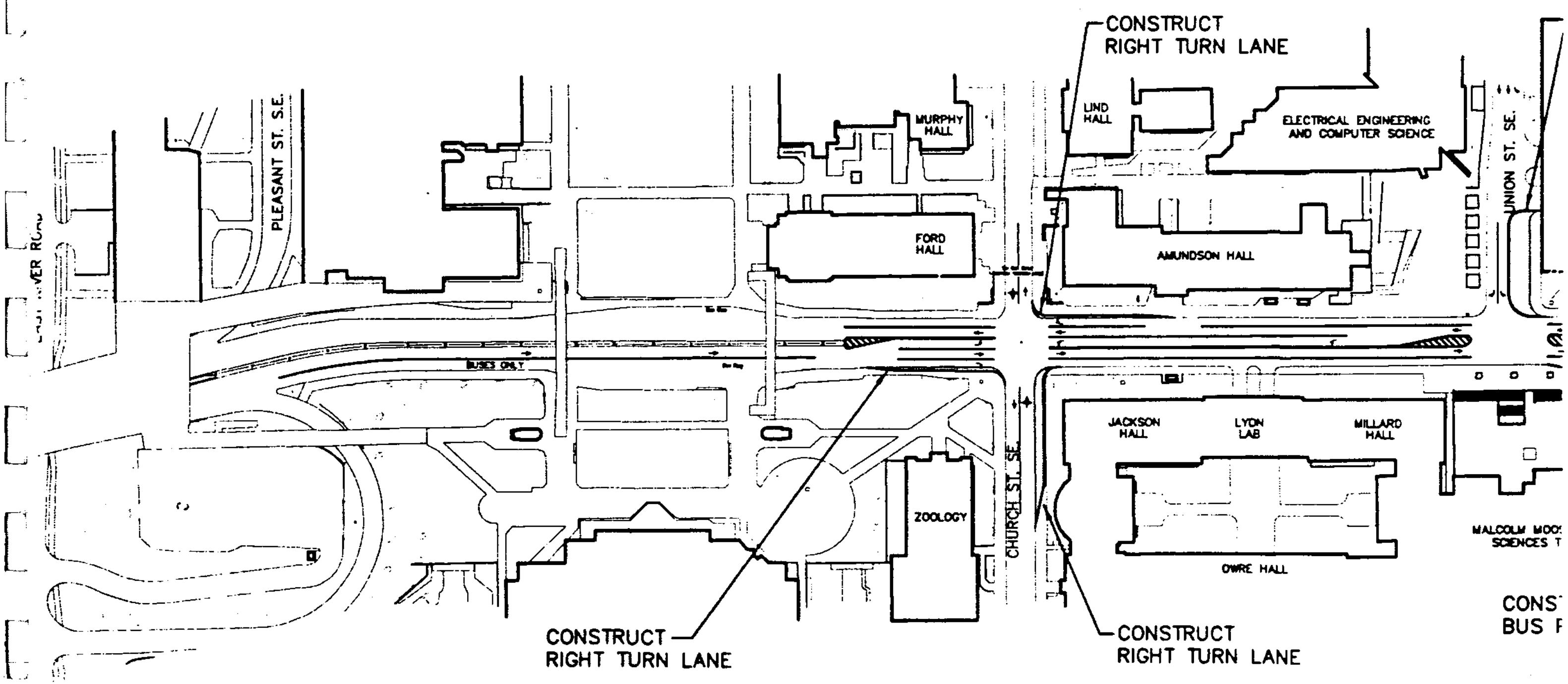
1. Restripe Washington Avenue as a three lane roadway.
2. Provide marking for shoulders to designate them as bike lanes.
3. Consolidate bus stops to two locations: in front of Coffman Union and between Harvard Street and Union Street.
4. Eliminate parking on Washington Avenue between Harvard Street and Oak Street.
5. Construct right-turn lanes on Washington Avenue at each intersection, where applicable.
6. Widen the south approach of Church Street to add a right-turn lane.
7. Widen the south approach of Harvard Street to add a left-turn lane.
8. Increase the cycle length and modify the signal timing to allow for more green time for Washington Avenue.

The improvements listed above would result in the following benefits:

- Exclusive lanes for vehicles turning right and left
- Designated lanes for bicyclists
- A staging area for transit vehicles
- No reduction in the level of service or the travel speed
- A potential reduction in accidents
- A through lane that is free of obstructions
- With the elimination of parking, fewer conflicts on Washington Avenue



WASHINGTON AVENUE (MIDBLOCK)



RECOMMENDED IMPROVEMENTS

1. RESTRIPE WASHINGTON AVENUE AS THREE LANE ROADWAY.
2. CONSOLIDATE BUS STOPS TO IN FRONT OF COFFMAN UNION AND BETWEEN HARVARD AND UNION.
3. ELIMINATE PARKING ON WASHINGTON AVENUE.
4. CONSTRUCT RIGHT TURN LANES ON WASHINGTON AVENUE.
5. WIDEN SOUTH APPROACH OF CHURCH STREET TO ADD RIGHT TURN LANE.
6. WIDEN SOUTH APPROACH OF HARVARD STREET TO ADD LEFT TURN LANE.
7. INCREASE CYCLE LENGTH TO 120 SECONDS AND MODIFY SIGNAL TIMING.

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

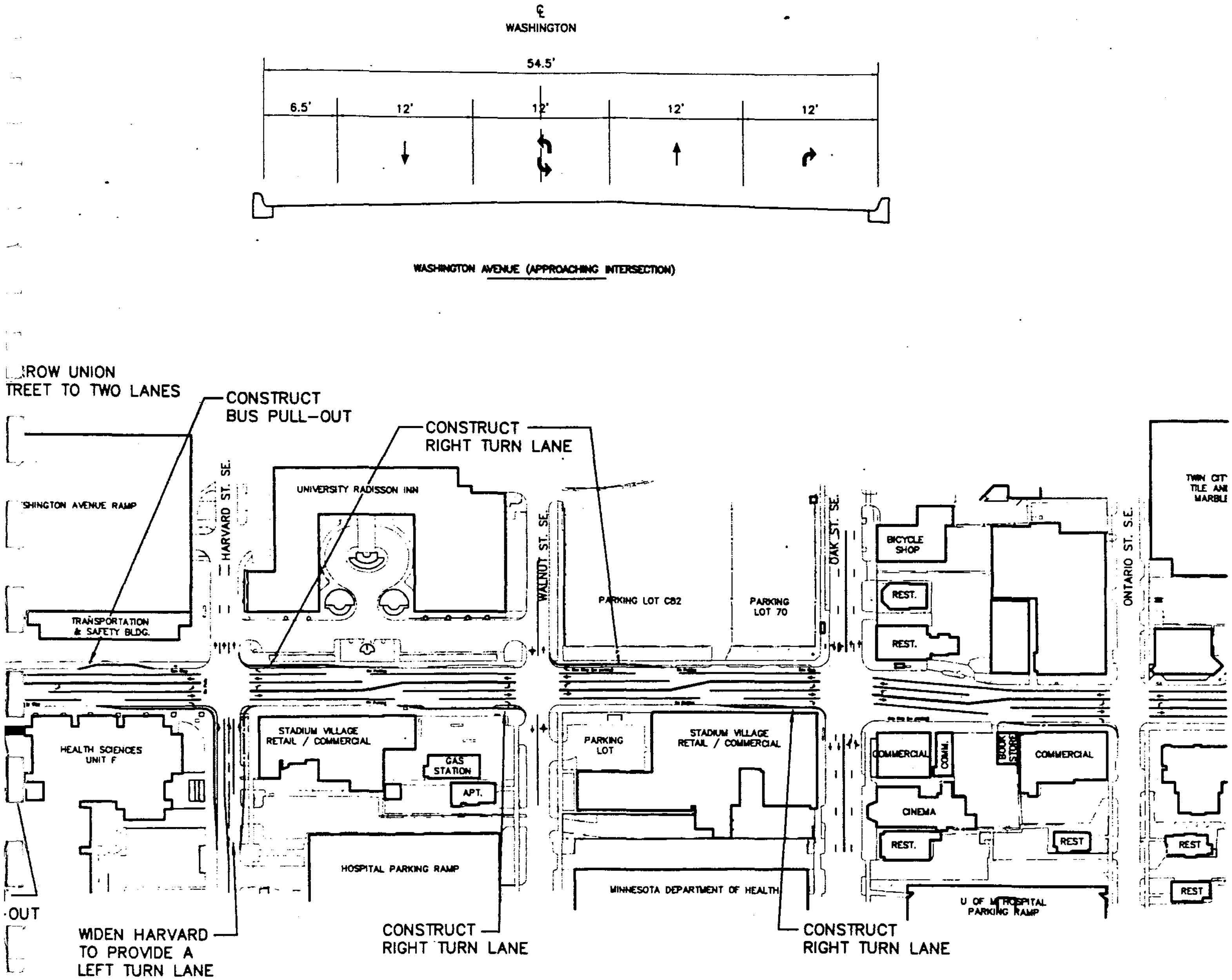


Figure A-1
Washington Avenue Recommended Improvements

PEDESTRIAN SCRAMBLE PHASE

Due to the large number of pedestrians walking along and crossing Washington Avenue, and the conflicts between crossing pedestrians and turning vehicles, a pedestrian scramble phase was considered to allow pedestrians to cross while no vehicles are moving. Likewise, no pedestrians would be allowed to cross during a vehicle phase.

A pedestrian scramble phase is made up of two parts. The first part consists of the time when the pedestrian indication reads WALK. Typical times for this phase are 4 to 7 seconds. Seven seconds was used for this analysis. The second part of the vehicle phase consists of the pedestrian clearance interval, or the phase when the pedestrian indication is FLASHING DON'T WALK. The time for FLASHING DON'T WALK is based on the amount of time a pedestrian can safely cross the street. The FLASHING DON'T WALK (FDW) time can be calculated as follows:

FDW = Distance Traveled / Pedestrian Rate

In this case, the farthest distance to be traveled by a pedestrian during a scramble phase is crossing Washington Avenue, which is approximately 50 feet. The typical speed of a pedestrian is 4 feet per second. Therefore, the FDW time is 50/4 = 12.5 seconds. The pedestrian scramble phase is then equal to 7 + 12.5 = 19.5 sec, say 20 seconds.

The pedestrian scramble phase was added to the existing cycle length, increasing the cycle length on Washington Avenue from 100 seconds to 120 seconds.

An intersection capacity analysis was conducted using the methods of the Highway Capacity Manual (HCM). The results indicate that the pedestrian scramble phase will increase the average vehicular delay by 50 to 70 percent. The new timings were also input into the TRAF-NETSIM model. The results are documented in Table A-1. The analysis indicates that the travel speed on Washington Avenue would become slower, and the delay would increase, resulting in LOS F operations in the Eastbound direction, and LOS D operations in the Westbound direction.

Although the implementation of a pedestrian scramble phase would theoretically eliminate conflicts between vehicles and pedestrians, a pedestrian scramble phase would add significant delay to vehicles on Washington Avenue and on the side streets. In addition, there is no guarantee that pedestrians in the University area would obey the DON'T WALK portions of the signal cycle. A pedestrian scramble phase should not be considered for the Washington Avenue corridor.

TABLE A-1
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
ADD PEDESTRIAN SCRAMBLE PHASE

DIRECTION OF TRAVEL: West to East

		EXISTING - OPTIMIZED OFFSETS TRAF-NETSIM MODEL			ADD PEDESTRIAN SCRAMBLE TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.							
	780	41.8	12.7	D	58.7	9.1	D
Church St.							
	520	18.7	19.0	B	99.9	3.5	F
Union St.							
	400	25.7	10.6	D	107.9	2.5	F
Harvard St.							
	420	14.1	20.3	B	14.7	19.4	B
Walnut St.							
	420	34.0	8.4	E	34.0	8.4	E
Oak St.							
SUBTOTALS	**2,540**	**134.3**	**12.9**	**D**	**315.2**	**5.5**	**F**

DIRECTION OF TRAVEL: East to West

		EXISTING TRAF-NETSIM MODEL			ADD PEDESTRIAN SCRAMBLE TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.							
	420	13.2	21.6	B	13.7	20.7	B
Walnut St.							
	420	25.6	11.2	D	45.0	6.4	F
Harvard St.							
	400	18.6	14.6	C	39.9	6.8	F
Union St.							
	520	31.0	11.3	D	61.1	5.7	F
Church St.							
	780	22.2	23.9	B	24.3	21.9	B
Pleasant St.							
SUBTOTALS	**2,540**	**110.6**	**15.7**	**C**	**184**	**9.4**	**D**

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVICE	AVERAGE TRAVEL SPEED (MPH)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source: BRW, Inc.
B:\LOTUS\ADDPED.WK4

07/18/97

CHURCH STREET

This alternative included adding a right turn lane on the south approach of Washington Avenue, and providing access (in only) to the new parking ramp.

Currently, volumes on the south approach are split evenly between vehicles turning left and right. Therefore, the addition of a right-turn lane would essentially double the storage capacity of the south approach. Based on the existing volumes, the right-turn lane should be constructed at least 150 feet long.

Providing access to the ramp from Church Street would increase the volume of vehicles turning left from the east approach and vehicles turning right from the west approach.

Because the south approach has additional capacity from the new right-turn lane, some time can be taken from that phase and given to Washington Avenue. However, due to the large number of pedestrians, only about five seconds can be taken, leaving 25 seconds for the Church Street movement.

The AM peak period would be the critical time period for the Church Street intersection, since the access to the ramp would be provided via Church Street. Based on a new 2,500 space ramp and the existing ramp characteristics, the ramp would generate 500 inbound trips.

The additional traffic volumes, new signal timing, and lane geometry modifications were made to the TRAF-NETSIM model. Table A-2 documents the results. Analysis indicates that if access to the ramp is provided from Church Street, the speed on Washington Avenue in the westbound direction will become slower and the delay will increase, resulting in LOS F operations.

The results of the simulation analysis indicates the following:

- Providing access to the parking ramp facility from Church Street would result in adverse traffic impacts on Washington Avenue under both the existing four-lane undivided and the three lane alternative.

- A right-turn lane added to the south approach of Church Street would increase capacity and storage.

- Providing unlimited access to the ramp is not recommended. However, a small number of short term parking spaces could be accessed to serve potential short term retail.

TABLE A-2
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
ADD RT LANE ON SOUTH APPROACH OF CHURCH
ALLOW ACCESS TO RAMP FROM CHURCH (IN ONLY)

DIRECTION OF TRAVEL: West to East

		EXISTING - OPTIMIZED OFFSETS TRAF-NETSIM MODEL			RAMP ACCESS TO CHURCH TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.							
	780	41.8	12.7	D	54.0	9.8	D
Church St.							
	520	18.7	19.0	B	66.3	5.3	F
Union St.							
	400	25.7	10.6	D	89.8	3.0	F
Harvard St.							
	420	14.1	20.3	B	15.1	18.9	C
Walnut St.							
	420	34.0	8.4	E	36.5	7.9	E
Oak St.							
SUBTOTALS	**2,540**	**134.3**	**12.9**	**D**	**261.7**	**6.6**	**F**

DIRECTION OF TRAVEL: East to West

		EXISTING TRAF-NETSIM MODEL			RAMP ACCESS TO CHURCH TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.							
	420	13.2	21.6	B	32.2	8.8	E
Walnut St.							
	420	25.6	11.2	D	144.7	2.0	F
Harvard St.							
	400	18.6	14.6	C	110.7	2.5	F
Union St.							
	520	31.0	11.3	D	168.7	2.1	F
Church St.							
	780	22.2	23.9	B	24.4	21.8	B
Pleasant St.							
SUBTOTALS	**2,540**	**110.6**	**15.7**	**C**	**480.7**	**3.6**	**F**

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVICE	AVERAGE TRAVEL SPEED (MPH)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source: BRW, Inc.
B:\LOTUS\ADDCHURC.WK4

07/18/97

SAFETY ANALYSIS

The accident history for Washington Avenue from the river to University Avenue was obtained from Mn/DOT for the three year period from 1994 to 1996.

The accident history for Washington Avenue is summarized in Table A-3 and indicates the following:

- The Washington Avenue corridor has experienced a total of 172 accidents in the last three years (an average of 58 accidents per year).

- A review of the accident data indicates that most of the accident types were coded as "Other". Therefore, no definitive conclusions can be made based on the type of accident.

- The accident severity data indicates that 27% of the accidents involve personal injury, which is slightly lower than the statewide average. This is reasonable given the lower speeds currently being experienced on the corridor.

Typical accident rates have been developed based on the accident history on the Mn/DOT trunk highway system. Figures A-2 and A-3 illustrate typical accident rates by roadway segment type and intersection traffic control type. A review of the typical accident rates by roadway segment facility type (Figure A-2) indicates the following:

- The average accident rate for four-lane undivided roadways (like Washington Avenue) is 6.75 accidents per million vehicle miles.

- The accident rate for a four-lane undivided roadway is the highest of any urban roadway facility type.

- The accident rate for a three lane roadway is approximately 25% lower than the rate for 4-lane undivided roadways.

A review of the typical accident rates by intersection traffic control (Figure A-3) indicates the following:

- The typical accident rate for signalized intersections is approximately 1.2 accidents per million entering vehicles. Signalized intersections with left-turn lanes have accident rates that are approximately ten percent lower than signalized intersections without left-turn lanes.

- The typical accident rate for unsignalized intersections is approximately 0.5 accidents per million vehicles.

TABLE A-3
WASHINGTON AVENUE
ACCIDENT HISTORY

REFERENCE POINT	INTERSECTION	NUMBER OF ACCIDENTS				TYPE OF ACCIDENT							ACCIDENT SEVERITY		
		TOTAL	1994	1995	1996	REAR END	SIDE SWIPE	LEFT TURN	OFF ROAD	RIGHT ANGLE	HEAD ON	OTHER	FATAL	PERSONAL INJURY	PROPERTY DAMAGE
000+00.837	East River Road / Pleasant	10	2	5	3	2	0	1	1	0	1	5	0	4	6
		7	1	4	2		1		1		1	4	0	2	5
000+00.870	Church Street	22	4	10	8	2	0		0	1	2	17	0	8	14
		7	3	1	3	2	1		1			3	0	1	6
000+00.968	Union Street	9	1	4	4		0		0	2		7	0	3	6
		10	2	4	4	2	1		0			7	0	3	7
001+00.046	Harvard Street	19	3	8	8	1	0	1	1	1		15	0	4	15
		11	3	3	5	1	1		0			9	0	3	8
001+00.123	Walnut Street	21	7	9	5	1	0	1	0	1		18	0	6	15
		4	0	2	2		0		0			4	0	0	4
001+00.201	Oak Street	22	8	4	10	2	0	1	0	2		17	0	6	16
		10	3	4	3	2	1		0	2		5	0	4	6
001+00.444	University Avenue	20	7	8	5		3	1	0	2		14	0	3	17
WASHINGTON AVENUE		**172**	**44**	**66**	**62**	**15**	**8**	**5**	**4**	**11**	**4**	**125**	**0**	**47**	**125**

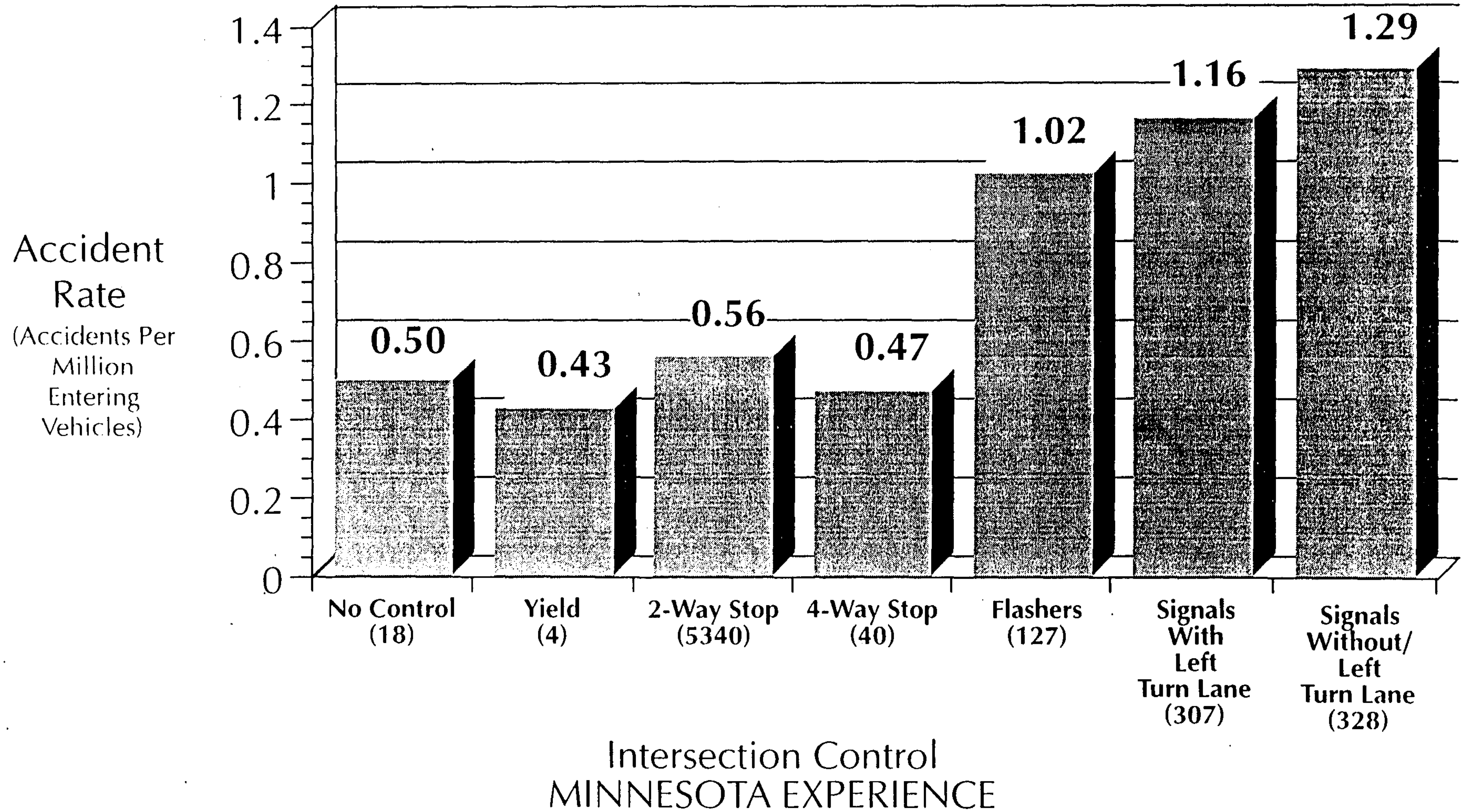
Conclusions:

(1) Most of the accidents are coded as "Other". Therefore, no conclusion can be made based on the Type of Accidents.

(2) The Accident Severity data indicates that 27% of the accidents involve personal injury, which is slightly lower than the statewide average.

Source: BRW, Inc., using MnDOT MRIS Accident Listing

B:\LOTUS\ACCRATE.WK4 07/18/97



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Source: Mn/DOT (1981-1991) Accident Data. Only State Highway Intersections

Intersection Accident Rates by Control Type

Figure 1B

A-3

Accident rates and critical accident rates were calculated for the key intersections on Washington Avenue, as well as the Washington Avenue corridor. If the accident rate is higher than the typical accident rate for a similar facility, the accident rate is compared to the critical accident rate.

The critical accident rate is a measure used by traffic engineers to determine if an intersection is hazardous, or if the accident rate is higher than the average rate due to the random nature of accidents. The accident rates for the Washington Avenue intersections and roadway segment are documented in Table A-4 and described below.

- The accident rates for the signalized intersections on Washington Avenue are at or below the typical accident rate for signalized intersections, indicating that there is not an accident problem at these locations.

- The accident rate for the Washington Avenue / Walnut Street unsignalized intersection is greater than the average accident rate for unsignalized intersections (see Figure A-3), and is greater than the critical accident rate, indicating a potentially hazardous location.

- The Washington Avenue four-lane undivided roadway segment has an accident rate that is higher than the statewide average for similar roadways (see Figure A-2). The accident rate is also higher than the critical accident rate, indicating a potentially hazardous roadway segment.

- Conversion of Washington Avenue to a three lane roadway section would likely result in a significant reduction in accidents.

BIKE LANE CRITERIA

Under the three lane alternative, the Washington Avenue typical section is proposed to consist of three 12 foot lanes and two 6.5 foot shoulders. Based on a review of design criteria, specifically, "Selecting Roadway Design Treatments to Accommodate Bicycles", FHWA, January 1994, the minimum width for a designated bike lane is five feet. Therefore, the proposed shoulder width is sufficient to be striped as a bike lane.

TABLE A-4
WASHINGTON AVENUE
INTERSECTION AND ROADWAY SEGMENT ACCIDENT RATES

REFERENCE POINT	INTERSECTION	NUMBER OF ACCIDENTS TOTAL 1994-1996	NUMBER OF ACCIDENTS AVERAGE ACC/YR	ADT BY APPROACH NORTH	ADT BY APPROACH EAST	ADT BY APPROACH SOUTH	ADT BY APPROACH WEST	AVERAGE DAILY TRAFFIC ENTERING INTERSECTION	MILLION ENTERING VEHICLES (MV)	ACCIDENT RATE	CRITICAL ACCIDENT RATE
000+00.837	East River Road / Pleasant	10	3.3	4,300	17,800	0	23,600	25,000	9.1	0.37	0.83
000+00.870	Church Street	22	7.3	500	17,800	3,300	17,800	19,700	7.2	1.02	1.80
000+00.968	Union Street	9	3.0	4,600	17,800	NA	17,800	22,400	8.2	0.37	1.77
001+00.046	Harvard Street	19	6.3	0	17,800	NA	17,800	17,800	6.5	0.97	1.83
001+00.123	Walnut Street	21	7.0	2,200	17,000	2,200	17,800	19,600	7.2	0.98	0.86
001+00.201	Oak Street	22	7.3	7,500	9,100	4,400	17,000	19,000	6.9	1.06	1.81
001+00.444	University Avenue	20	6.7	9,800	NA	19,500	11,000	20,150	7.4	0.91	1.80

ROADWAY	SEGMENT TYPE	NUMBER OF ACCIDENTS TOTAL 1994-1996	NUMBER OF ACCIDENTS AVERAGE ACC/YR	LENGTH OF SEGMENT FEET	LENGTH OF SEGMENT MILES	AVERAGE ADT	MILLION VEHICLE MILES (MVM)	ACCIDENT RATE	CRITICAL ACCIDENT RATE
WASHINGTON AVENUE (River to University)	4 - Lane Undivided	172	57.3	3,220	0.61	17,500	6.4	9.0	8.4

Conclusions:

(1) The signalized intersection accident rates are at or below the statewide average for signalized intersections (see Figure 11B).
(2) The accident rate for the Washington Avenue / Walnut Street intersection is greater than the average accident rate for unsignalized intersections (see Figure 11B), and is greater than the critical accident rate, indicating a potentially hazardous location.
(3) The Washington Avenue four-lane undivided roadway segment has an accident rate that is higher than the statewide average for similar roadways (see Figure 11A). The rate is also higher than the critical accident rate, indicating a potentially hazardous location.
(4) Conversion of Washington Avenue from a four-lane undivided roadway section to a three-lane or five-lane section would likely result in a significant reduction in accidents.

Source: BRW, Inc., using MnDOT MRIS Accident Listing
B:\LOTUS\ACCRATE.WK4

07/18/97

INCREASE CYCLE LENGTH (THREE LANE ALTERNATIVE)

The TRAF-NETSIM simulation of the three lane alternative using the existing cycle length of 100 seconds resulted in slightly worse travel speeds and level of service when compared to the existing four lane roadway. The decrease in speed was largely due to long delays experienced at the Church Street intersection, caused by insufficient green time to accommodate the volume.

The purpose of this analysis was to determine what effect lengthening the cycle lengths on Washington Avenue from 100 seconds to 120 seconds, with a majority of the extra time going to Washington Avenue, would have on the travel speed and level of service. Increasing the cycle length and increasing the green time would increase the capacity on Washington Avenue by increasing the percentage of the time the signal is green.

New signal timings were developed using the traffic operations software TRANSYT-7F. The new timings were input into TRAF-NETSIM for simulation. The results of the analysis are documented in Table A-5 and described below.

Results of the analysis indicates that the three lane alternative would operate slightly better than the existing conditions. The arterial level of service in both directions remains at LOS D, while the travel speeds become slightly faster.

The longer cycle length would result in increased delay for minor street traffic and pedestrians waiting to cross Washington Avenue. In addition, queues on the minor street would increase, due to the longer time between green indications. However, a review of the delay reported by TRAF-NETSIM and HCS indicates that all minor street movements would operate at an adequate level of service (LOS D or better).

It should be noted that the simulation model was run only for the PM Peak hour period. Comparison of the AM and PM peak hour volumes indicates that, in general, the AM peak hour volumes are lower. Therefore, it is expected that the overall corridor traffic operations would operate as well, if not better, than the level documented by the PM peak hour traffic simulation.

Implementing the three lane alternative and increasing the cycle length to at least 120 seconds would result in slightly improved traffic operations on Washington Avenue, without significantly impacting the cross street or pedestrian traffic.

RG/ash

File #10731-003-0101

TABLE A-5
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
Alternative #7a
COMPARISON OF EXISTING CONDITIONS TO THREE LANE ALTERNATIVE
INCREASE CYCLE LENGTH TO 120 SECONDS

DIRECTION OF TRAVEL: West to East

		EXISTING FIELD MEASURED			EXISTING TRAF-NETSIM MODEL			THREE LANE ALTERNATIVE TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.										
	780	36.8	14.5	C	41.6	12.9	D	37.3	14.3	C
Church St.										
	520	44.2	8.0	E	40.9	8.7	E	41.9	8.4	E
Union St.										
	400	43.0	6.3	F	41.6	6.6	F	19.8	13.7	C
Harvard St.										
	420	12.8	22.4	B	14.4	19.9	B	13.0	22.0	B
Walnut St.										
	420	32.4	8.8	E	34.2	8.4	E	23.7	12.1	D
Oak St.										
SUBTOTALS	2,540	169	10.2	D	172.7	10.0	D	135.7	12.8	D

DIRECTION OF TRAVEL: East to West

		FIELD MEASURED			EXISTING TRAF-NETSIM MODEL			THREE LANE ALTERNATIVE TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TIME (SEC)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.										
	420	15.4	18.6	C	13.0	21.9	B	12.7	22.5	B
Walnut St.										
	420	49.0	5.8	F	33.3	8.6	E	23.0	12.4	D
Harvard St.										
	400	40.2	6.8	F	33.7	8.1	E	46.0	5.9	F
Union St.										
	520	44.4	8.0	E	39.0	9.0	D	56.1	6.3	F
Church St.										
	780	21.8	24.4	B	22.9	23.2	B	26.3	20.2	B
Pleasant St.										
SUBTOTALS	2,540	171	10.1	D	141.9	12.2	D	164.1	10.6	D

ARTERIAL LEVEL OF SERVICE (Table 11-1, Highway Capacity Manual) Free-flow speeds of 35 to 25 mph		
LEVEL OF SERVICE	AVERAGE TRAVEL SPEED (MPH)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source: BRW, Inc.
B:\LOTUS\3LN120.WK4

07/18/97

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

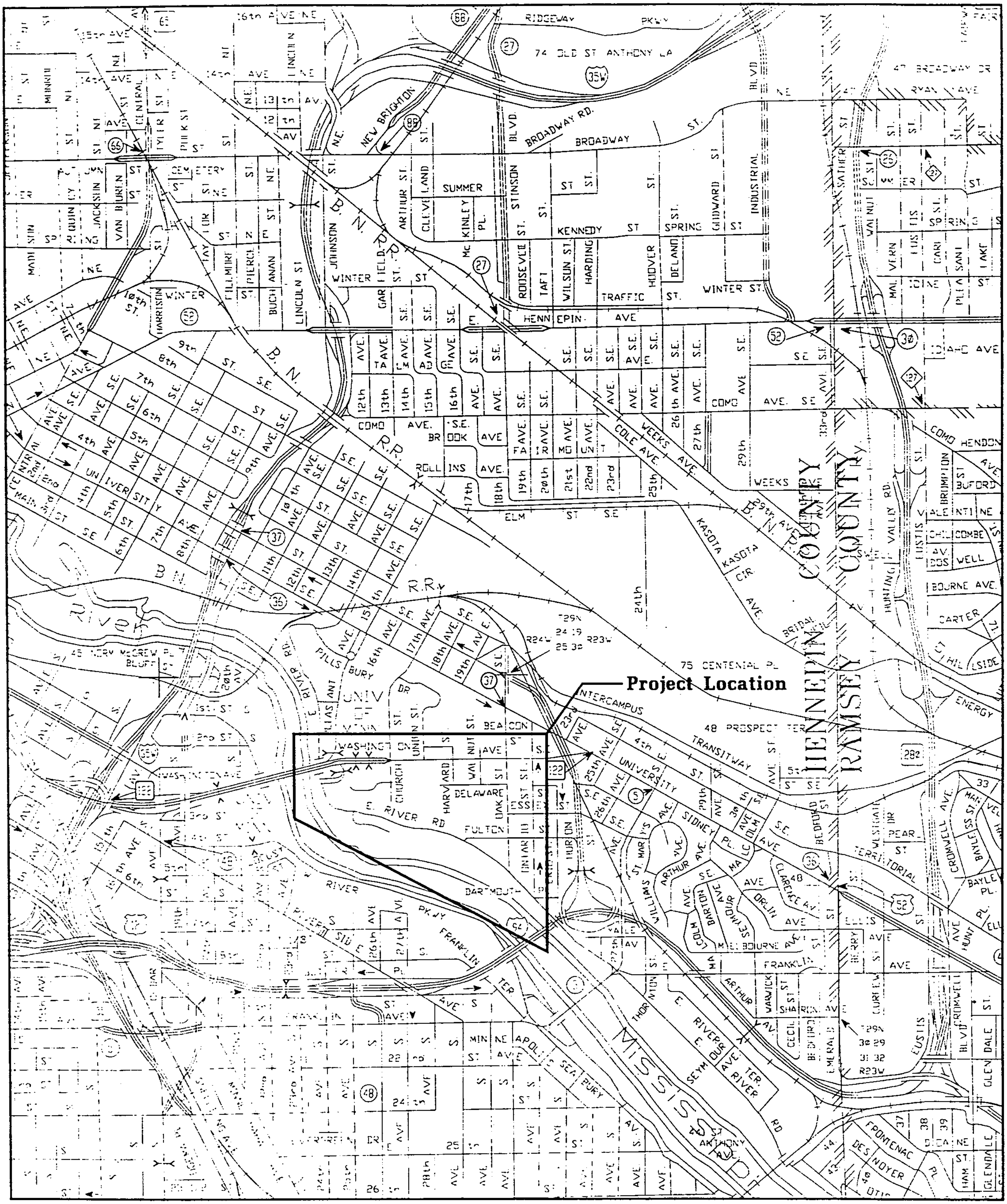
The University of Minnesota is currently considering several alternative development scenarios that could affect traffic patterns on the south end of the campus (Figure 1) and, particularly, Washington Avenue. Given present perceptions about the quality and traffic operations along Washington Avenue, the University was interested in understanding the potential traffic implications associated with the development scenarios, particularly as they relate to Washington Avenue.

Washington Avenue is currently a four-lane undivided roadway that serves as a minor arterial through the study area and is an integral part of the Metropolitan Area Regional Road System. As a result of the minor arterial roadway classification, Washington Avenue legitimately serves a through traffic function. However, because of the unique location in the heart of the University of Minnesota's campus, Washington Avenue also must accommodate a large number of buses, heavy pedestrian traffic and a high frequency of closely spaced intersections. In addition, because of the roadway cross-section, four-lane undivided, the inside lane is frequently clogged with left turning vehicles waiting for gaps in oncoming traffic and the outside lane is clogged with right turning vehicles waiting for pedestrians to clear the intersection. As a result of these conflicts, the roadway is congested during large portions of the day, with average travel speeds on the roadway during the AM, Midday, and PM peak periods approaching 10 miles per hour.

Development alternatives being considered by the University of Minnesota include the following:

- The University is evaluating the possibility of replacing and/or enlarging the East River Road Ramp. Prior to initiating the programming and predesign phase of a replacement ramp south of Coffman Memorial Union (CMU), the University wants to know whether traffic operations on Washington Avenue would be affected by the size of the ramp or considerations to provide alternative access to the new ramp, including the impact of creating another intersection on Washington Avenue.

- In addition, the recent merger of University Hospital with Fairview Hospitals may also result in a demand for additional patient parking facilities in this area. U of M staff want to understand the impacts of future development proposals and or significant changes in facilities utilization.



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

BRW

NORTH
Scale: 1" = 2000'

Figure 1
Project Location

With these potential changes in mind and the concern for traffic conditions along Washington Avenue, University of Minnesota staff wanted a traffic impact analysis completed using a traffic simulation model that could provide information related to traffic operations for the specific alternatives noted above, as well as future development proposals and or significant changes in facilities utilization in the study area. The University of Minnesota retained BRW to provide traffic engineering services including the creation of a TRAF-NETSIM simulation model that could simulate existing conditions and proposed alternatives, including changes to the roadway system and development in the study area.

This report documents the results and conclusions of the traffic simulation study and is organized into the following sections:

- Existing Conditions
- Traffic Impact Analysis of Alternatives
- Alternatives Analysis
- Study Conclusions

EXISTING CONDITIONS

In order to determine the current level of traffic operations in the study area (Figure 2), data was gathered to accurately represent the existing conditions. The following paragraphs describe the data collected, including functional classification, roadway geometrics, traffic control, existing traffic volumes, travel times and field observations, and roadway segment capacity analysis.

FUNCTIONAL CLASSIFICATION

The Washington Avenue corridor through the University of Minnesota serves conflicting purposes. Washington Avenue is a minor arterial roadway that serves a heavy through movement between downtown Minneapolis and University Avenue SE.

However, Washington Avenue has several features that are more typical of lower volume collector streets, including:

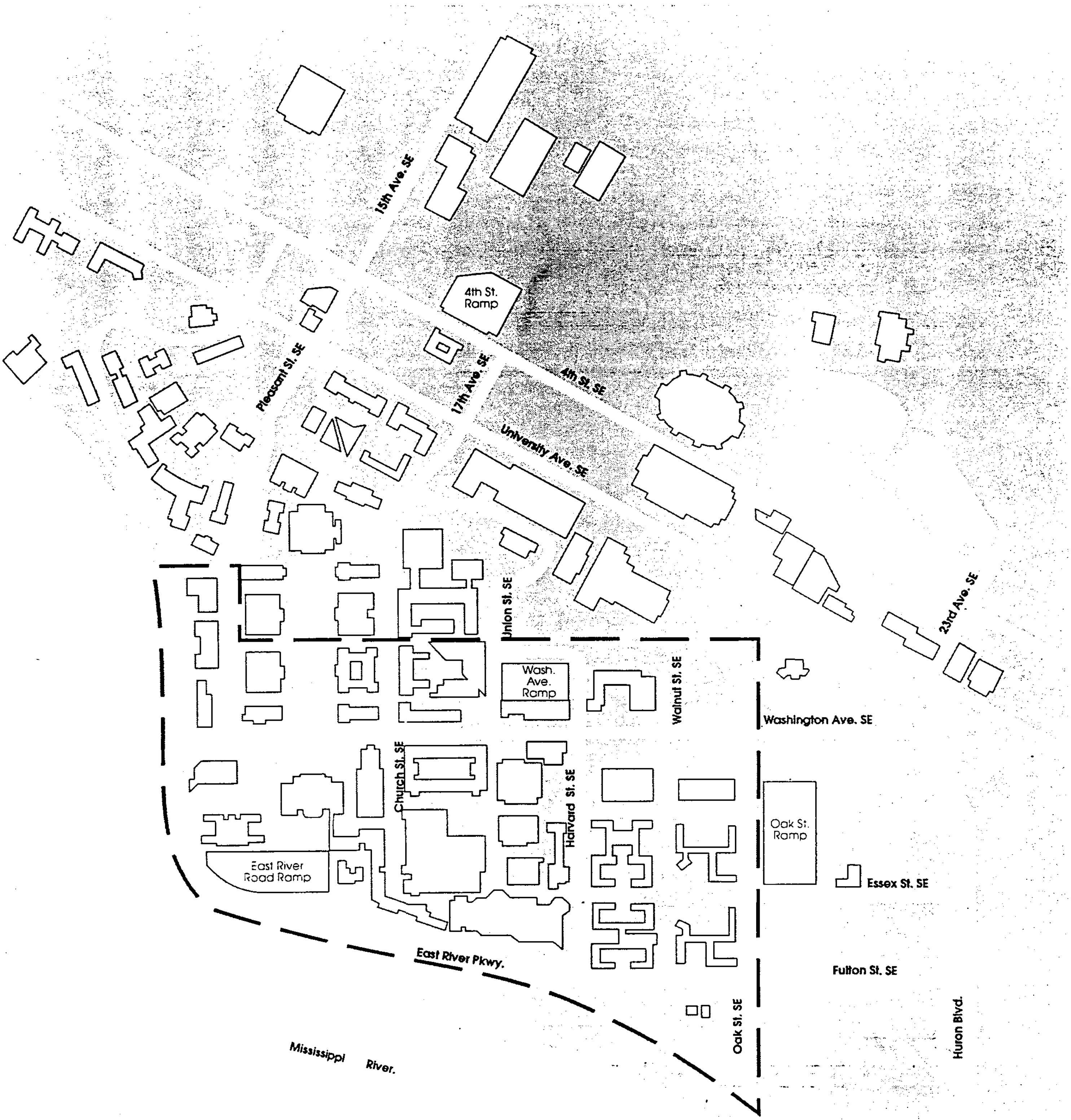
- Washington Avenue is the transit route for the MCTO Route 16, as well as several University of Minnesota routes and circulators. There are approximately 500 buses daily and 50 in the PM peak hour that use Washington Avenue.

- The University campus runs along and spans both sides of Washington Avenue. Therefore, large numbers of pedestrians walk along and cross Washington Avenue. As part of the University of Minnesota TBI Study in 1991, pedestrian levels on Washington Avenue reached 4,000 on a daily basis and 800 in the PM peak hour.

- Washington Avenue provides access from downtown Minneapolis and I-35W and West Bank to University parking ramps and facilities.

- Several businesses currently front Washington Avenue between Harvard Street and Oak Street. On-street parking currently exists on both sides of Washington Avenue.

The competition for space along Washington Avenue among through traffic, buses, pedestrians and turning traffic results in the conflicts that produce the poor quality of existing traffic operations.



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

March 12, 1997

North 0' 300' 600'

Figure 2

Study Area

ROADWAY GEOMETRICS

Washington Avenue is currently a four-lane undivided roadway between Church Street and Oak Street with a speed limit of 30 mph (Figure 3). Washington Avenue does not have separate left turn lanes in the project area. The current typical sections for Washington Avenue are shown in Figure 4.

Parking is prohibited west of Harvard Street. Metered parking is available on both sides of Washington Avenue between Harvard Street and Oak Street. During the AM and PM peaks (7-9 am and 4-6 pm), parking is prohibited. Bus bays are provided on both sides of Washington Avenue in front of Coffman Union.

There are five at-grade intersections on Washington Avenue in the project area: Church Street, Union Street, Harvard Street, Walnut Street, and Oak Street. The average intersection spacing is 420 feet. On the west end of the study area at Pleasant Street, there is currently a ramp from eastbound Washington to East River Road and a right turn from southbound Pleasant to westbound Washington Avenue.

Church Street is currently closed north of Washington Avenue. Union and Harvard form a one-way circle around the Washington Avenue Ramp.

TRAFFIC CONTROL

The traffic control and signal timing splits for the key intersections in the study area are shown in Figure 5. The intersections of Washington Avenue with Church Street, Union Street, Harvard Street, and Oak Street are signalized. The Pleasant Street and Walnut Street intersections are controlled by stop signs.

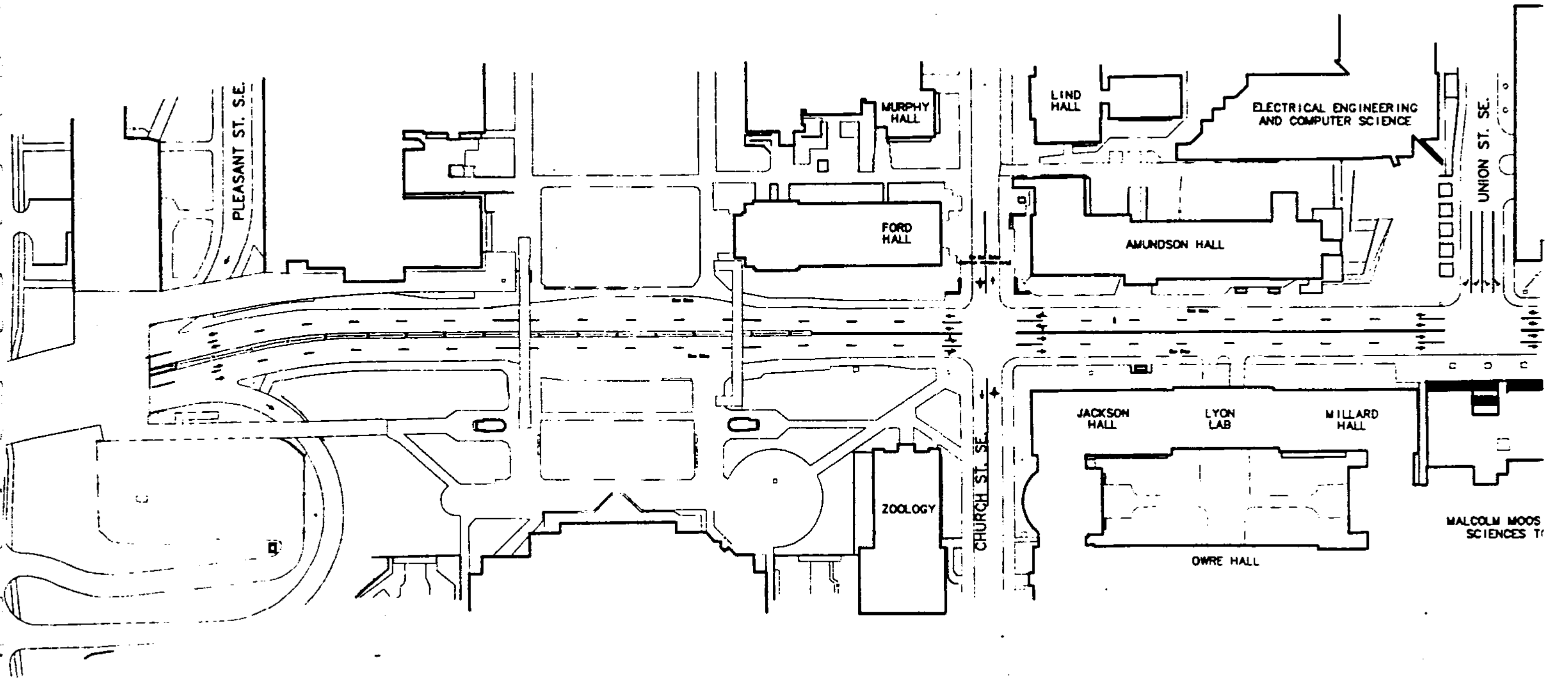
The traffic signal phasing is two phase with the following exceptions:

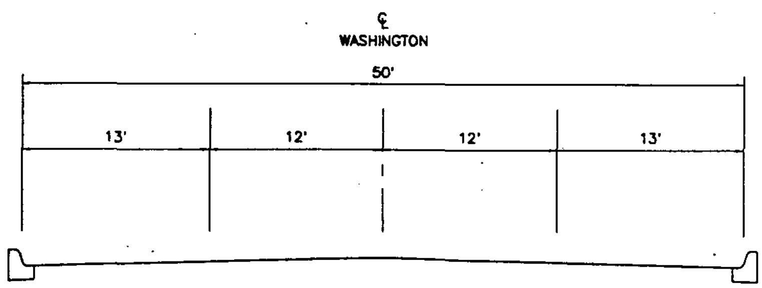
- Church Street phasing includes a protected/permitted left turn phase for the westbound direction.

- Harvard Street phasing includes a protected/permitted left turn phase for the eastbound direction.

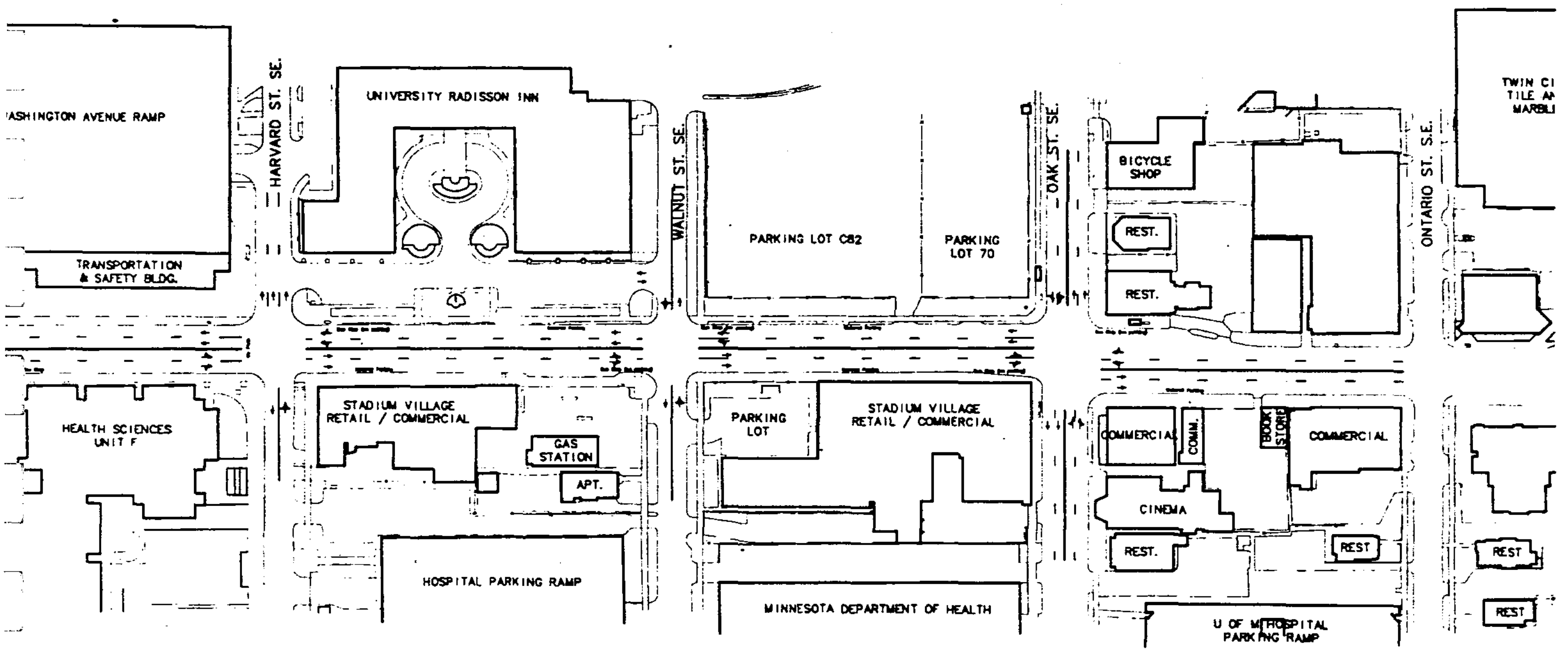
EXISTING TRAFFIC VOLUMES

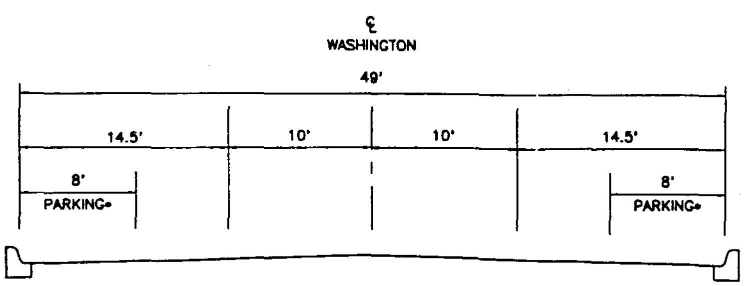
Daily traffic volumes were obtained from the City of Minneapolis and are shown in Figure 6. Traffic levels on the Washington Avenue bridge currently exceed 23,000 vehicles per day. Between Pleasant Street and Oak Street, the daily volume is approximately 17,000 vehicles per day.





WASHINGTON AVENUE
WEST OF HARVARD



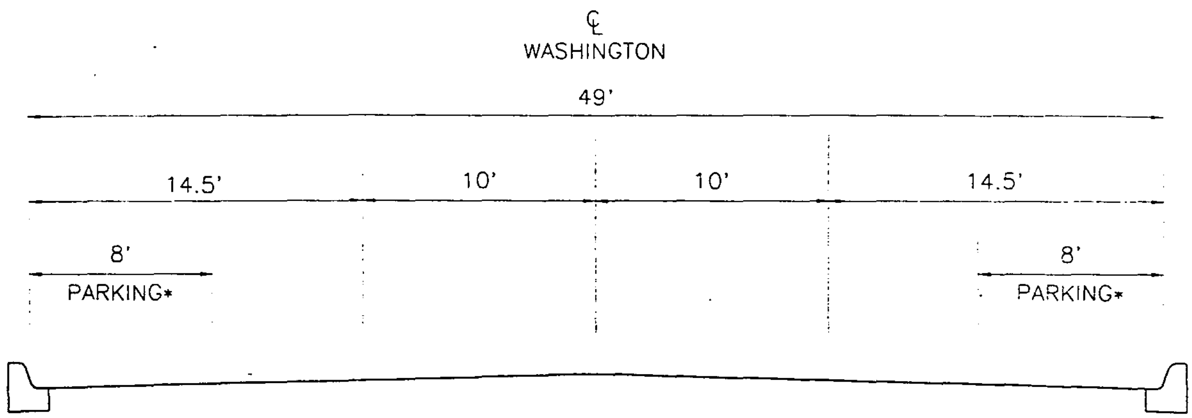


WASHINGTON AVENUE
BETWEEN HARVARD AND OAK

* PROHIBITED FROM 3PM–6PM

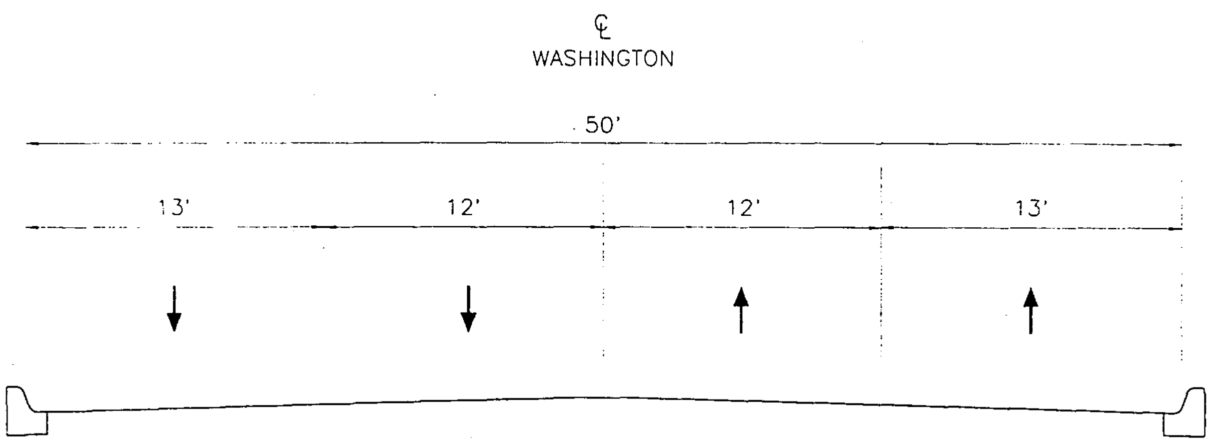
200'

Figure 3
Washington Avenue
Lane Geometry



WASHINGTON AVENUE
BETWEEN HARVARD AND OAK

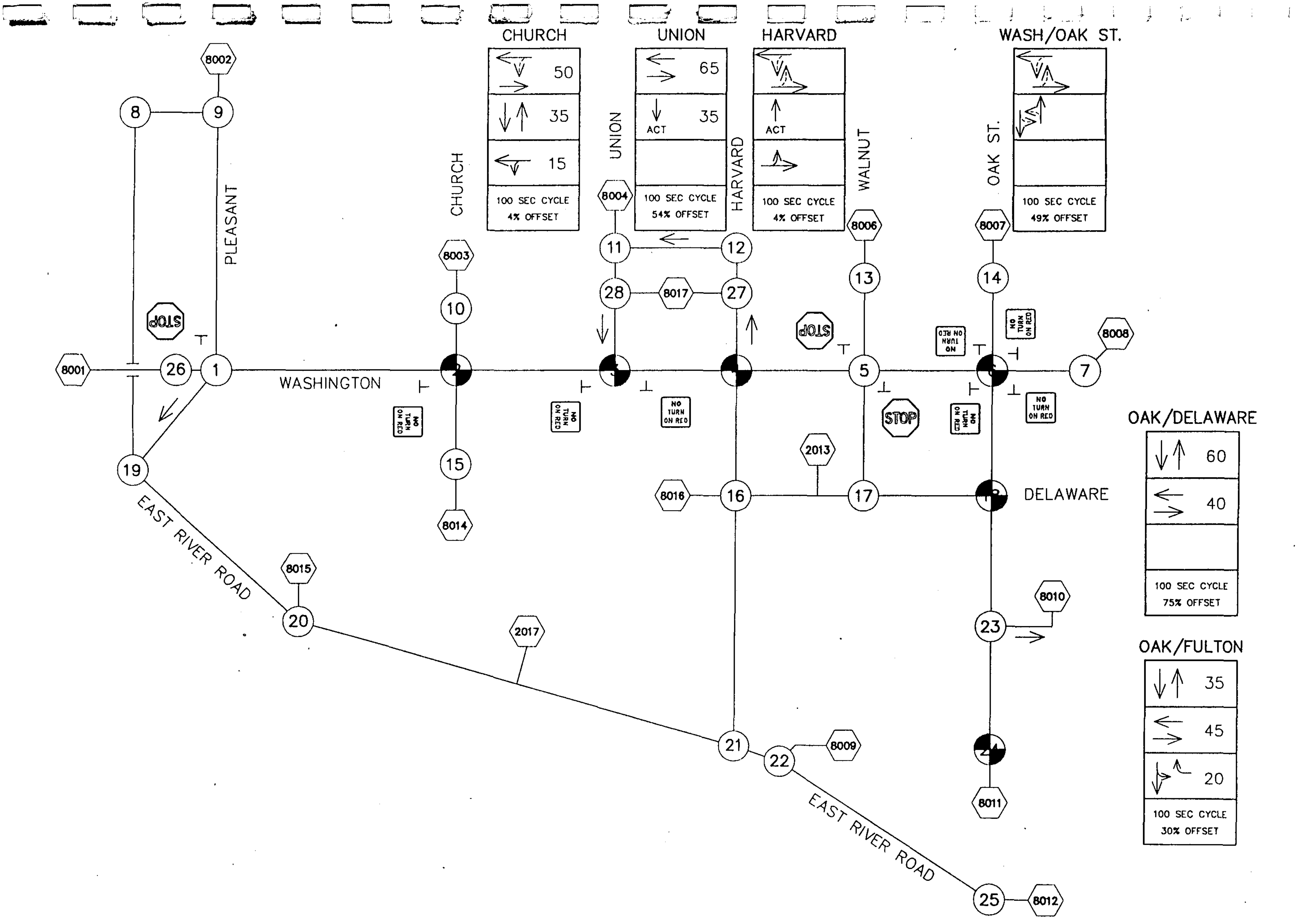
* PROHIBITED FROM 3PM–6PM



WASHINGTON AVENUE
WEST OF HARVARD

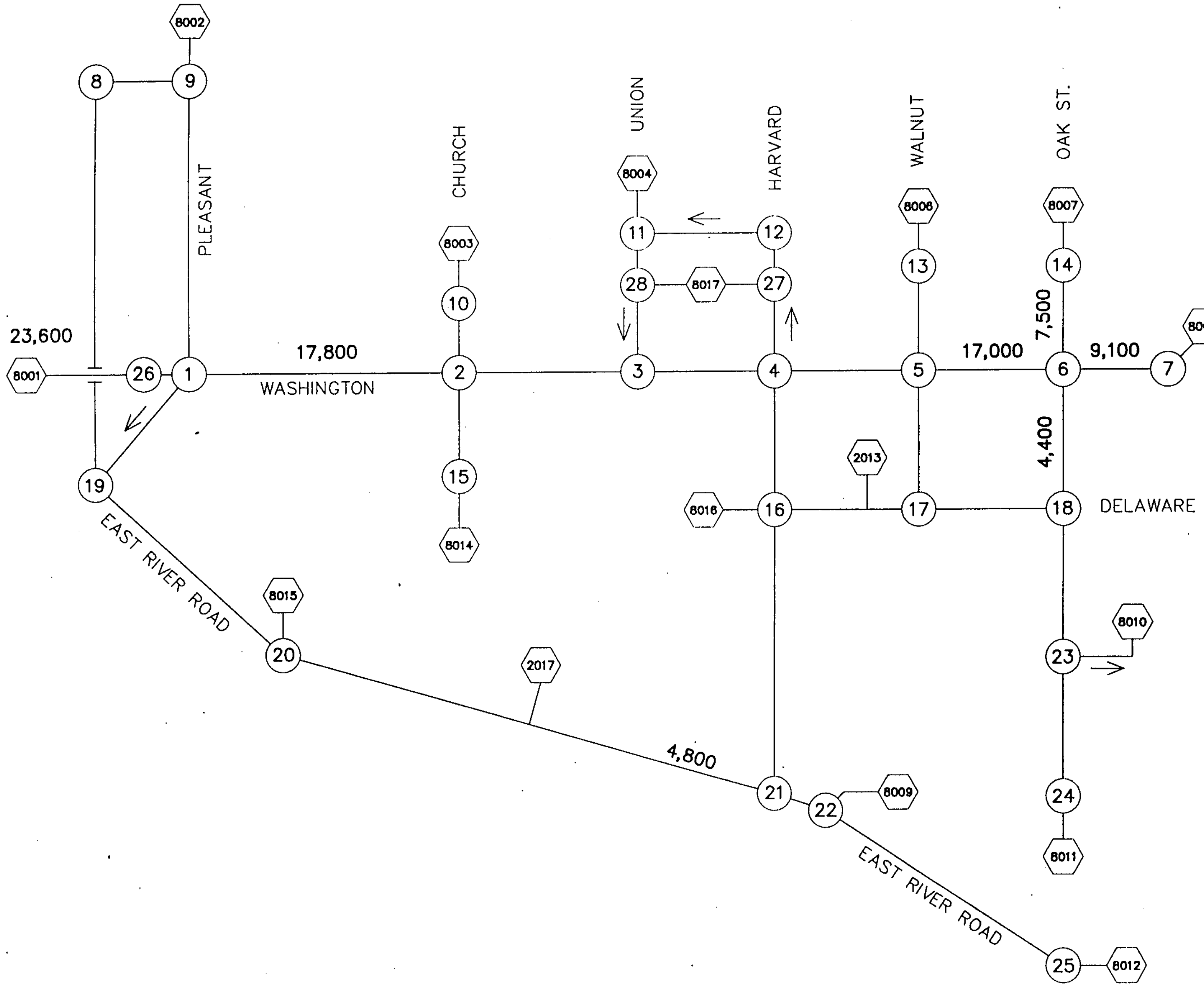
University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 4
Washington Avenue
Typical Sections
Existing Conditions



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 5
Traffic Control
Traffic Signal Phasing and Timing
PM Peak Hour (3pm to 6pm)



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 6
Average Daily Traffic
SOURCE: CITY OF MINNEAPOLIS 1993

PM peak hour approach volumes for the study area are shown in Figure 7 and were developed using the following methodology:

- Previous reports were reviewed, including the Travel Behavior Inventory (1992), Motley Bypass Traffic Study (1989). In particular, the TBI study was used to develop the cross street volumes at Pleasant, Church, Union, Harvard, and Walnut Streets.

- Data for entrance and exit volumes from the East River Road, Washington Avenue, and Oak Street ramps was obtained from the University of Minnesota Parking and Transportation Services (1996).

- The City of Minneapolis has four count stations on Washington Avenue. PM peak hour volumes were obtained from their most recent counts (1993).

PM peak hour turning movement volumes and percentages were developed for the 15 intersections using the following methodology:

- Fifteen minute turning movement counts were conducted at 15 intersections between 3:30 to 5:30 pm on September 5th (Figure 8). Although school was not in session, it was assumed that the turning movement percentages would be consistent with traffic patterns when school was in session.

- Previous PM peak hour turning movement counts were reviewed. The fifteen minute counts were found to closely represent the actual turning percentages.

- Based on engineering judgement, turning movement percentages were developed based on the fifteen minute counts and adjusted where appropriate to reach a balanced network (Figure 9).

TRAVEL TIME RUNS AND FIELD OBSERVATIONS

In order to calibrate the TRAF-NETSIM model and to document actual traffic conditions while school is in session, travel time runs were conducted on Washington Avenue on October 2nd, 1996. Travel time runs were conducted for the PM, Midday, and AM peak periods and are documented in Tables 1, 2, and 3. Analysis of the travel times indicates the following:

- The average travel speed between Pleasant Street and Oak Street during the PM peak period is 10 mph in both directions. In the Midday peak period, the eastbound travel speed was 9 mph and the westbound travel speed was 13 mph. In the AM peak period, the travel speed was 8.8 and 20.6 mph for the eastbound and westbound directions, respectively.

- In the eastbound direction, the slowest travel speed consistently occurred between Harvard and Union Street. In the westbound direction, the slowest travel speed occurred between Walnut and Harvard Street.

TABLE 1
MEASURED TRAVEL TIME AND DELAY
WASHINGTON AVENUE
PM PEAK PERIOD

DIRECTION OF TRAVEL: West to East

CROSS STREET	Trip Number 1 04:55pm TIME (Sec)	DELAY (Sec)	Trip Number 2 05:07pm TIME (Sec)	DELAY (Sec)	Trip Number 3 05:20pm TIME (Sec)	DELAY (Sec)	Trip Number 4 05:33pm TIME (Sec)	DELAY (Sec)	Trip Number 5 05:43pm TIME (Sec)	DELAY (Sec)	AVERAGE PM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.																
	38	15	23	-	35	8	25	-	63	34	36.8	11.4	780	14.5	20.9	C
Church St.																
	38	19	51	29	46	22	45	20	41	16	44.2	21.2	520	8.0	15.4	E
Union St.																
	39	19	48	22	36	15	79	65	13	-	43.0	24.2	400	6.3	14.5	F
Harvard St.																
	12	-	12	-	13	-	11	-	16	-	12.8	-	420	22.4	22.4	B
Walnut St.																
	45	30	41	20	42	24	12	-	22	-	32.4	14.8	420	8.8	16.3	E
Oak St.																
SUBTOTALS	172	83	175	71	172	69	172	85	155	50	169	72	2540	10.2	17.9	D

DIRECTION OF TRAVEL: East to West

CROSS STREET	Trip Number 1 05:02pm TIME (Sec)	DELAY (Sec)	Trip Number 2 05:12pm TIME (Sec)	DELAY (Sec)	Trip Number 3 05:27pm TIME (Sec)	DELAY (Sec)	Trip Number 4 05:37pm TIME (Sec)	DELAY (Sec)	Trip Number 5 05:48pm TIME (Sec)	DELAY (Sec)	AVERAGE PM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Oak St.																
	14	-	21	-	14	-	12	-	16	-	15.4	-	420	18.6	18.6	C
Walnut St.																
	43	20	44	21	44	26	44	23	70	45	49.0	27.0	420	5.8	13.0	F
Harvard St.																
	41	22	48	27	41	22	40	19	31	8	40.2	19.6	400	6.8	13.2	F
Union St.																
	45	23	40	14	48	20	43	18	46	14	44.4	17.8	520	8.0	13.3	E
Church St.																
	22	-	20	-	21	-	21	-	25	-	21.8	-	780	24.4	24.4	B
Pleasant St.																
SUBTOTALS	165	65	173	62	168	68	160	60	188	67	171	64	2540	10.1	16.2	D

TOTALS PM PEAK PERIOD		WASHINGTON AVE West to East		East to West	
Trip Length		2540	Feet	2540	Feet
Trip Time		2.8	Min	2.9	Min
Stopped Delay		1.2	Min	1.1	Min
Running Time =	Trip Time - Stopped Delay =	1.6	Min	1.8	Min
Travel Speed =	Trip Length / Trip Time =	10.2	mph	10.1	mph
Running Speed =	Trip Length / Running Time =	17.9	mph	16.2	mph

Note Level of Service based on Table 11-1 Arterial Level of Service, Highway Capacity Manual

Source BRW Inc
R 3532 LOTUS\TRAVPM WK4

03/13/97

TABLE 2
MEASURED TRAVEL TIME AND DELAY
WASHINGTON AVENUE
MIDDAY PEAK PERIOD

DIRECTION OF TRAVEL: West to East

CROSS STREET	Trip Number 1 11:52 am TIME (Sec)	DELAY (Sec)	Trip Number 2 12:01 pm TIME (Sec)	DELAY (Sec)	Trip Number 3 12:11 pm TIME (Sec)	DELAY (Sec)	Trip Number 4 12:21 pm TIME (Sec)	DELAY (Sec)	Trip Number 5 12:33 pm TIME (Sec)	DELAY (Sec)	AVERAGE PM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.																
	30	11	13	-	72	40	27	-	19	-	32.2	10.2	780	16.5	24.2	C
Church St.																
	15	-	43	25	48	26	129	94	46	27	56.2	34.4	520	6.3	16 3	F
Union St.																
	64	53	66	48	18	-	59	35	62	28	53.8	32.8	400	5.1	13.0	F
Harvard St.																
	13	-	20	-	12	-	14	-	13	-	14.4	-	420	19.9	19 9	B
Walnut St.																
	37	26	15	-	44	-	71	35	16	-	36.6	12.2	420	7.8	11 7	E
Oak St.																
SUBTOTALS	159	90	157	73	194	66	300	164	156	55	193	90	2540	9.0	16 8	E

DIRECTION OF TRAVEL: East to West

CROSS STREET	Trip Number 1 11:57 am TIME (Sec)	DELAY (Sec)	Trip Number 2 12:04 TIME (Sec)	DELAY (Sec)	Trip Number 3 12:14 pm TIME (Sec)	DELAY (Sec)	Trip Number 4 12:26 pm TIME (Sec)	DELAY (Sec)	Trip Number 5 12:35 pm TIME (Sec)	DELAY (Sec)	AVERAGE PM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Oak St.																
	14	-	16	-	23	-	18	-	14	-	17.0	-	420	16.8	16 8	C
Walnut St.																
	50	43	67	55	61	34	62	49	67	54	61.4	47.0	420	4 7	19.9	F
Harvard St.																
	15	-	17	-	13	-	15	-	14	-	14.8	-	400	18.4	18 4	C
Union St																
	13	-	13	-	52	32	11	-	12	-	20.2	6.4	520	17.6	25 7	C
Church St																
	16	-	19	-	30	-	13	-	18	-	19.2	-	780	27.7	27 7	A
Pleasant St.																
SUBTOTALS	108	43	132	55	179	66	119	49	125	54	133	53	2540	13 0	21 6	C

TOTALS PM PEAK PERIOD		West to East		East to West	
Trip Length		2540	Feet	2540	Feet
Trip Time		3.2	Min	2.2	Min
Stopped Delay		1.5	Min	0.9	Min
Running Time =	Trip Time - Stopped Delay =	1.7	Min	1.3	Min
Travel Speed =	Trip Length / Trip Time =	9.0	mph	13.0	mph
Running Speed =	Trip Length / Running Time =	16.8	mph	21.6	mph

Note: Level of Service based on Table 11-1, Arterial Level of Service, Highway Capacity Manual

Source BRW, Inc
R :3832:LOTUS:TRAVMID.WK4

03:13:97

TABLE 3
MEASURED TRAVEL TIME AND DELAY
WASHINGTON AVENUE
AM PEAK PERIOD

DIRECTION OF TRAVEL: West to East

CROSS STREET	Trip Number 1 8:28 am TIME (Sec)	DELAY (Sec)	Trip Number 2 8:35 am TIME (Sec)	DELAY (Sec)	Trip Number 3 8:43 am TIME (Sec)	DELAY (Sec)	Trip Number 4 8:53 am TIME (Sec)	DELAY (Sec)	AVERAGE AM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.														
	23	-	46	34	26	-	178	134	68.3	42.0	780	7.8	20.3	E
Church St.														
	52	29	13	-	104	71	21	-	47.5	25.0	520	7.5	15.8	E
Union St.														
	17	-	42	35	37	21	56	23	38.0	19.8	400	7.2	14.9	E
Harvard St.														
	12	-	14	-	13	-	15	-	13.5	-	420	21.2	21.2	B
Walnut St.														
	48	37	10	-	13	-	49	34	30.0	17.8	420	9.5	23.4	D
Oak St.														
SUBTOTALS	152	66	125	69	193	92	319	191	197.0	105.0	2540	8.8	18.8	E

DIRECTION OF TRAVEL: East to West

CROSS STREET	Trip Number 1 8:32 am TIME (Sec)	DELAY (Sec)	Trip Number 2 8:38 am TIME (Sec)	DELAY (Sec)	Trip Number 3 8:47 am TIME (Sec)	DELAY (Sec)	Trip Number 4 9:00 am TIME (Sec)	DELAY (Sec)	AVERAGE AM PEAK TIME (Sec)	DELAY (Sec)	LENGTH (FEET)	TRAVEL SPEED (MPH)	RUNNING SPEED (MPH)	LEVEL OF SERVICE
Oak St.														
	14	-	14	-	10	-	10	-	12.0	-	420	23.9	23.9	B
Walnut St.														
	12	-	26	13	23	10	67	51	32.0	18.5	420	8.9	21.2	E
Harvard St.														
	11	-	10	-	11	-	11	-	10.8	-	400	25.4	25.4	A
Union St.														
	10	-	13	-	13	-	16	-	13.0	-	520	27.3	27.3	A
Church St.														
	15	-	17	-	16	-	18	-	16.5	-	780	32.2	32.2	A
Pleasant St.														
SUBTOTALS	62	0	80	13	73	10	122	51	84	19	2540	20.6	26.6	B

TOTALS AM PEAK PERIOD		West to East		East to West	
Trip Length		2540	Feet	2540	Feet
Trip Time		3.3	Min	1.4	Min
Stopped Delay		1.8	Min	0.3	Min
Running Time =	Trip Time - Stopped Delay =	1.5	Min	1.1	Min
Travel Speed =	Trip Length / Trip Time =	8.8	mph	20.6	mph
Running Speed =	Trip Length / Running Time =	18.8	mph	26.6	mph

Note: Level of Service based on Table 11-1, Arterial Level of Service, Highway Capacity Manual

Source BRW Inc
R:3832\LOTUS\TRAVAM.WK4

03/13/97

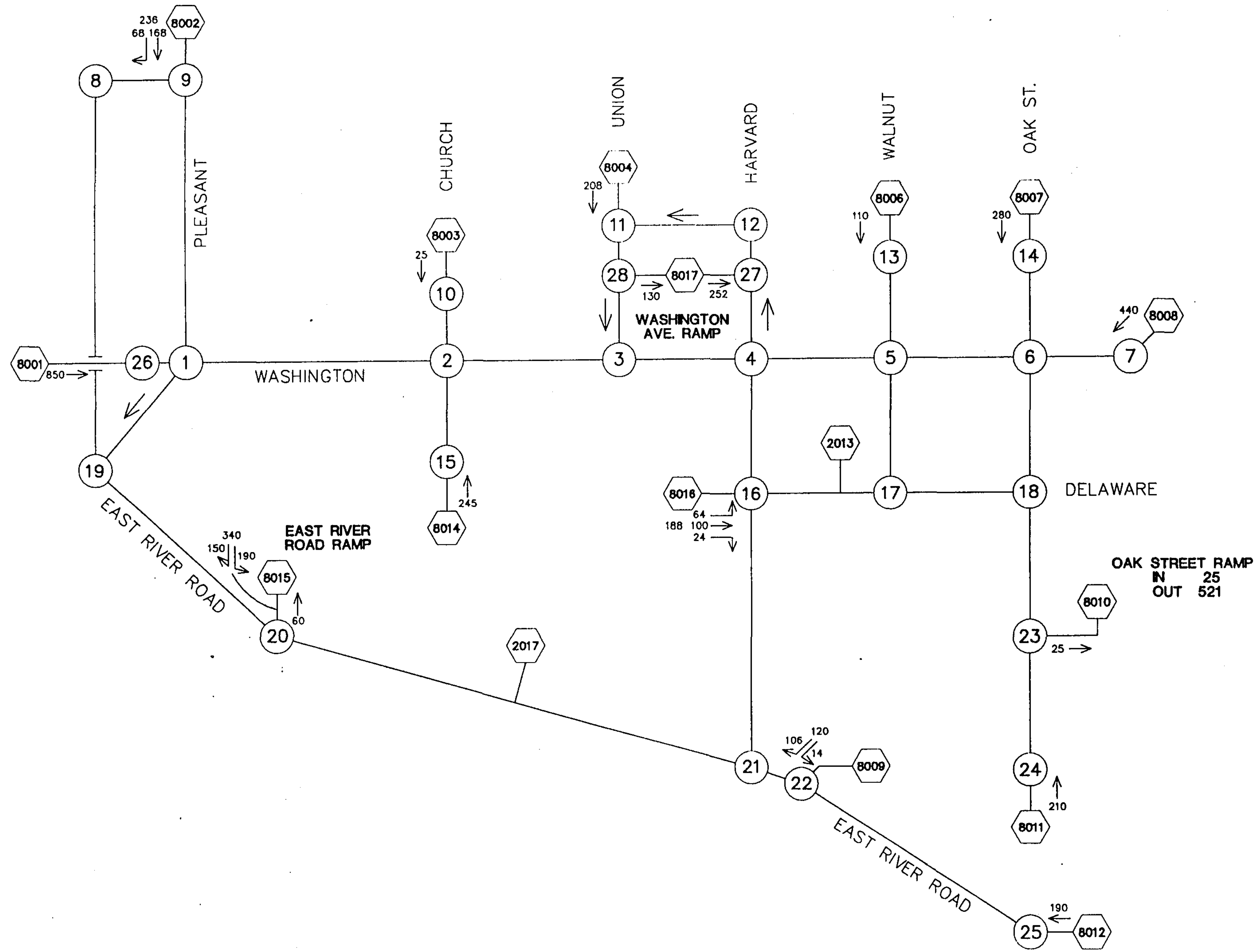
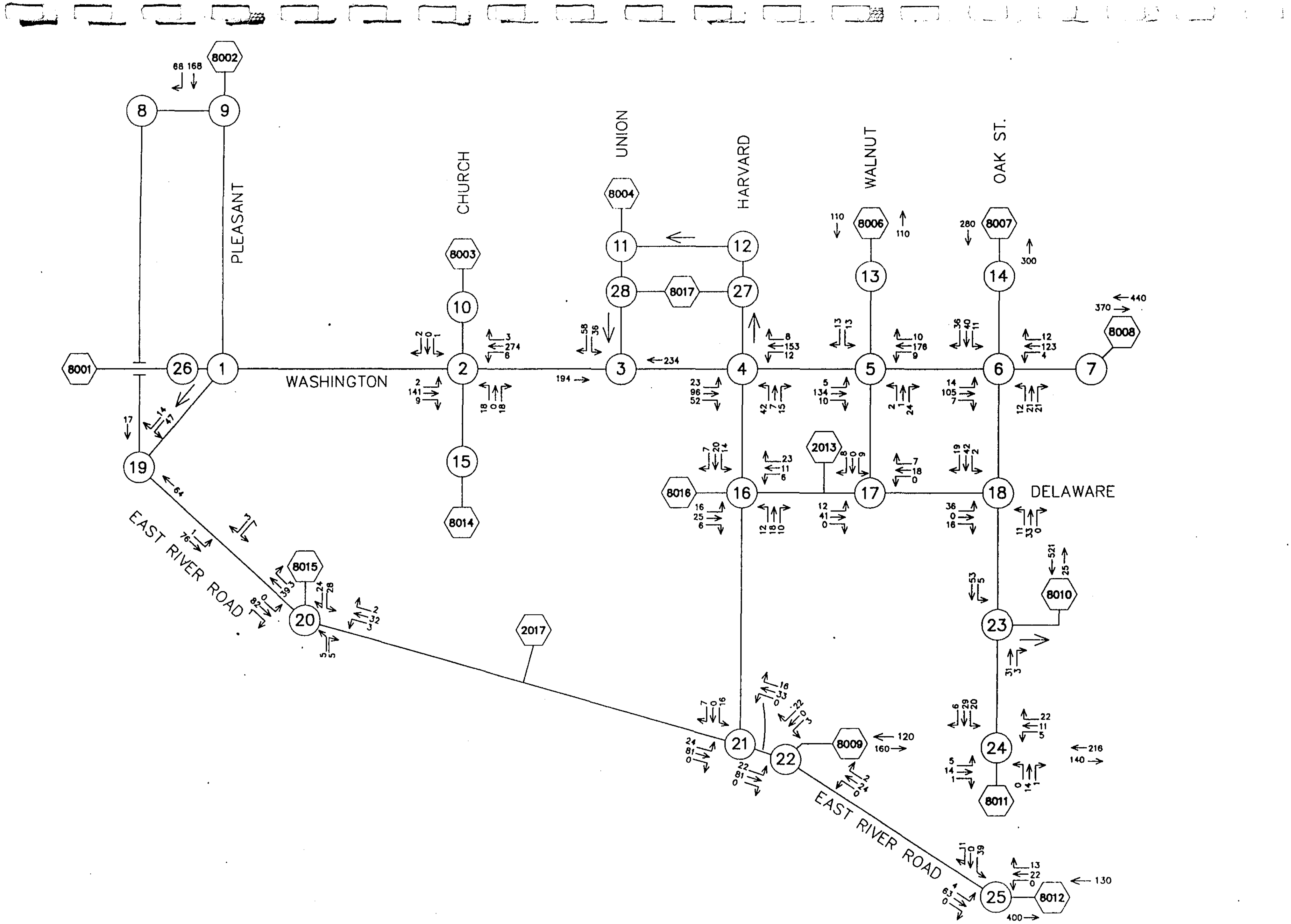


Figure 7
Entry-Link Volumes

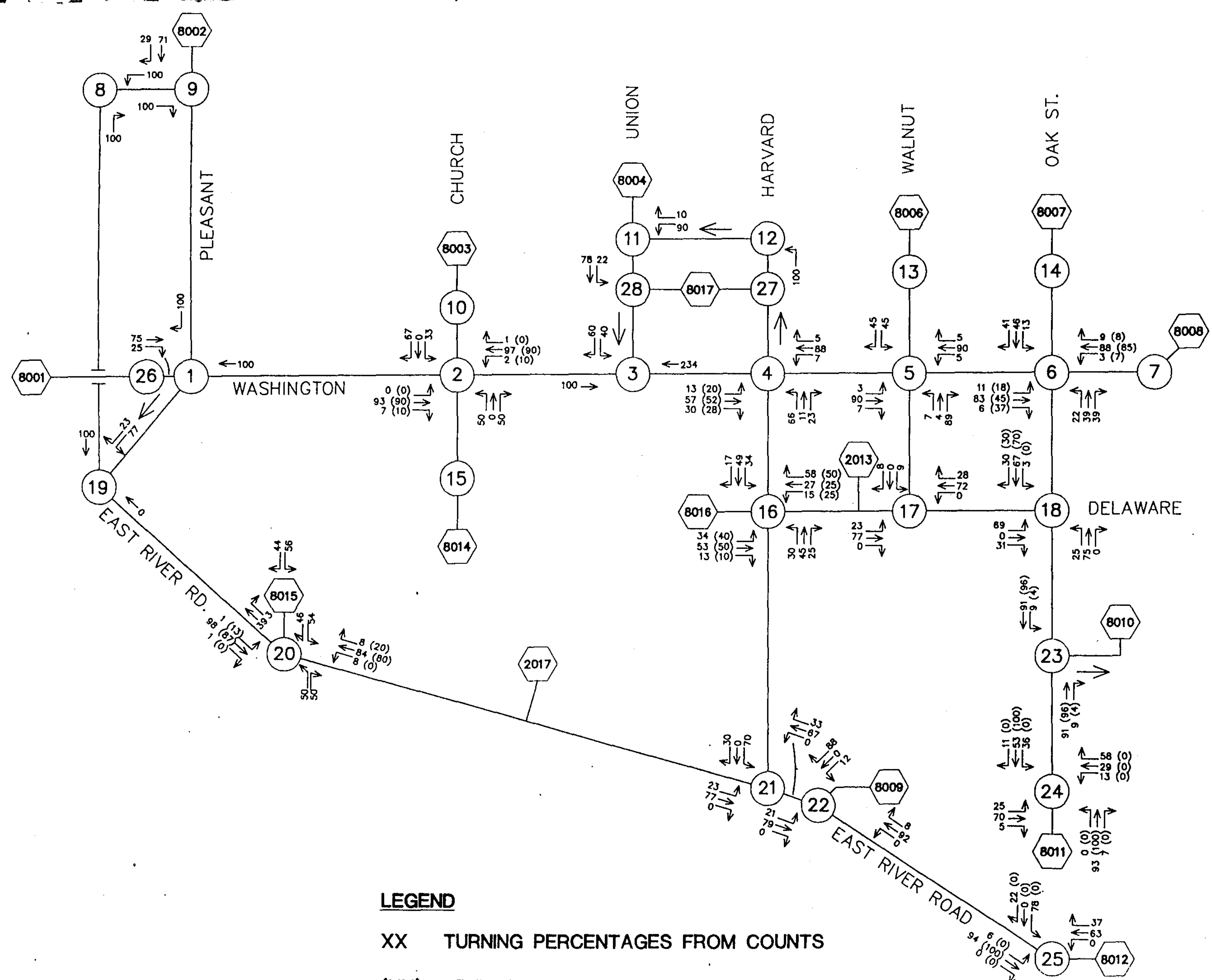
SOURCE: CITY OF MINNEAPOLIS 1993
TBI SPECIAL GENERATORS (U OF M) 1992
PARKING & TRANSPORTATIONS SERVICES (1996)

University of Minnesota
Traffic Simulation
Washington Avenue Corridor



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 8
Turning Movement Volumes
(15-minute between)



LEGEND

XX TURNING PERCENTAGES FROM COUNTS

(XX) ADJUSTED PERCENTAGES

Figure 9
Turning Movement Volumes
(15-minute between)

TABLE 4
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
EXISTING CONDITIONS
COMPARISON OF FIELD MEASURED AND TRAF-NETSIM

DIRECTION OF TRAVEL: West to East

		EXISTING CONDITIONS FIELD MEASURED			EXISTING CONDITIONS TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.							
	780	36.8	14.5	C	41.6	12.9	D
Church St.							
	520	44.2	8.0	E	40.9	8.7	E
Union St.							
	400	43.0	6.3	F	41.6	6.6	F
Harvard St.							
	420	12.8	22.4	B	14.4	19.9	B
Walnut St.							
	420	32.4	8.8	E	34.2	8.4	E
Oak St.							
SUBTOTALS	2540	169	10.2	D	172.7	10.0	D

DIRECTION OF TRAVEL: East to West

		EXISTING CONDITIONS FIELD MEASURED			EXISTING CONDITIONS TRAF-NETSIM MODEL		
CROSS STREET	LENGTH (FEET)	TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.							
	420	15.4	18.6	C	13.0	21.9	B
Walnut St							
	420	49.0	5.8	F	33.3	8.6	E
Harvard St.							
	400	40.2	6.8	F	33.7	8.1	E
Union St							
	520	44.4	8.0	E	39.0	9.0	D
Church St.							
	780	21.8	24 4	B	22.9	23.2	B
Pleasant St.							
SUBTOTALS	2540	171	10 1	D	141.9	12.2	D

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVIC	AVERAGE TRAVEL SPEED (mph)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source BRW Inc
R \3632\LOTUS\PMLOS WK4

The following observations of traffic conditions on Washington Avenue were made during the travel time runs:

- The intersection of Washington Avenue and Harvard Street acts as a bottleneck for eastbound traffic. At the intersection, there is a heavy left turn movement heading for the Washington Avenue Ramp. This left turn movement has to turn out of the inside through lane, effectively blocking the lane during peak periods. There is also a heavy right turn movement heading to the medical center parking facilities. This right turn movement is in conflict with a heavy pedestrian volume on the south leg of the intersection and significantly reduces the capacity of the outside through lane.

  Parking is currently allowed during the non-peak periods just east of the intersection between Harvard and Oak Street. Parked vehicles effectively block the outside lane. Therefore, there is no through lane free of obstacles.

- There is currently a heavy movement of pedestrians and bicyclists along Washington Avenue and across Washington Avenue. Vehicles turning right off of Washington Avenue are required to wait for a gap in pedestrian traffic. Right turning vehicles must turn out of the outside through lane, resulting in longer delays for through moving vehicles.

- Due to the conflicts mentioned above, Washington Avenue does not operate like a four-lane undivided roadway. The capacity of the inside through lanes is reduced due to the left turn conflicts and the capacity of the outside through lane is reduced because of conflicts with buses, pedestrians and parked cars.

ROADWAY SEGMENT CAPACITY ANALYSIS

A capacity analysis is an established method of objectively measuring the quality of traffic operations through an intersection or along a roadway segment. The basic output for these analyses are letter grades (A through F), with level of service (LOS) A denoting excellent operations or under capacity conditions, and LOS F signifying congested or over capacity conditions with long traffic delays. The LOS E/F boundary is generally considered the capacity of an intersection or roadway segment. In the Minneapolis metropolitan area, LOS D is considered to be an acceptable level of service for urban arterials.

A capacity analysis was conducted for Washington Avenue using three methods: a planning level analysis based on daily traffic volumes, and two detailed analyses based on the methods of "Chapter 11: Urban and Suburban Arterials" as described in the Highway Capacity Manual (HCM). The first detailed analysis used field measured travel times. The second detailed analysis used a software animation package called TRAF-NETSIM. Results of the analysis are documented in the following sections.

Planning Level

The level of service for two-lane, three-lane, four-lane undivided, and four-lane divided roadways based on daily traffic volumes is illustrated in Figure 10. The current daily traffic volume on Washington Avenue is 17,800 vehicles per day. Comparing the volume to the four-lane undivided roadway level of service results in LOS B traffic operations. However, as noted in the field observations, conflicts along the corridor do not allow Washington Avenue to operate as a four-lane undivided roadway. Therefore, the actual level of service is expected to be worse than reported by the four-lane undivided bar.

Travel Time Analysis

The Highway Capacity Manual uses travel speed to determine level of service for urban arterials. The level of service for roadways with similar characteristics to Washington Avenue is documented in Table 11-1 "Arterial Levels of Service" in the Highway Capacity Manual.

The average travel time runs for each time period were compared to the speeds listed above to develop level of service. The results are documented previously in Tables 1, 2, and 3 and indicate the following:

- In the PM peak period. the overall level of service on Washington Avenue between Pleasant Street and Oak Street is LOS D. Several segments are at or near capacity including Union to Harvard and Walnut to Union.

- In the Midday peak period, the level of service is LOS E and LOS C for the eastbound and westbound directions, respectively. Segments that are at or near capacity include Church to Harvard and Walnut to Harvard.

- In the AM peak period, the level of service is LOS E eastbound and LOS B westbound. All segments in the eastbound direction are near capacity.

TRAF-NETSIM Analysis

TRAF-NETSIM is an animation software package that simulates traffic conditions for an intersection or system of intersections. The software looks at vehicles in the system as individual entities (microscopically), providing a considerable level of accuracy and detail. In addition, TRAF-NETSIM provides an assumption of traffic conditions that can be used to demonstrate what effect changes to the roadway geometrics, traffic volumes, or signal phasing would have on traffic operations.

A simulation of the PM peak period conditions in the study area was conducted using the TRAF-NETSIM software. Entries to the TRAF-NETSIM network include geometrics, traffic volumes, bus routes, turn bay lengths, number of pedestrians, truck percentages, and signal timing. The roadway geometrics included in the model for the Washington Avenue simulation model are shown in Figure 11. The traffic volumes and signal timing data used in the model was shown previously in the documentation of existing conditions.

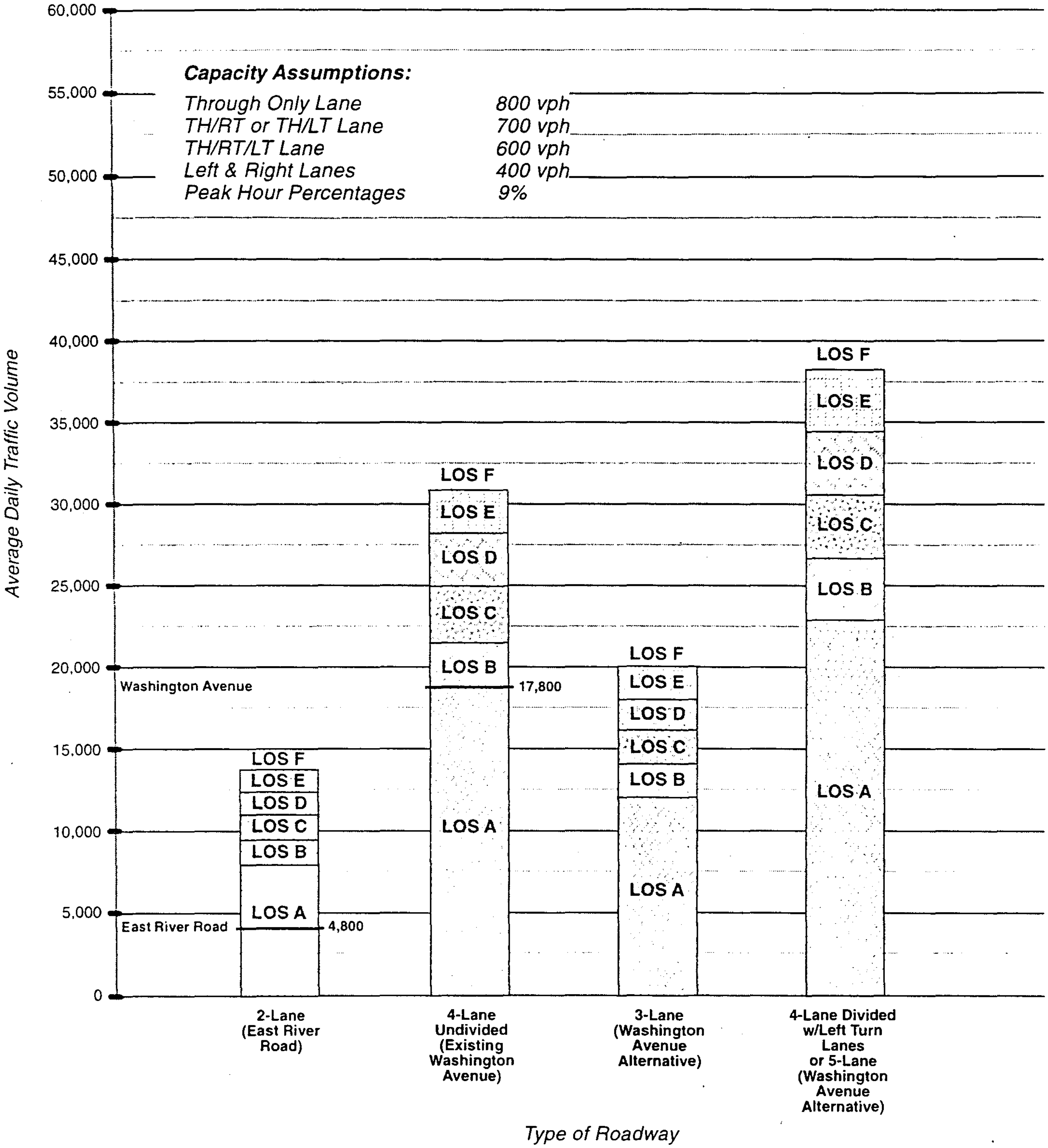
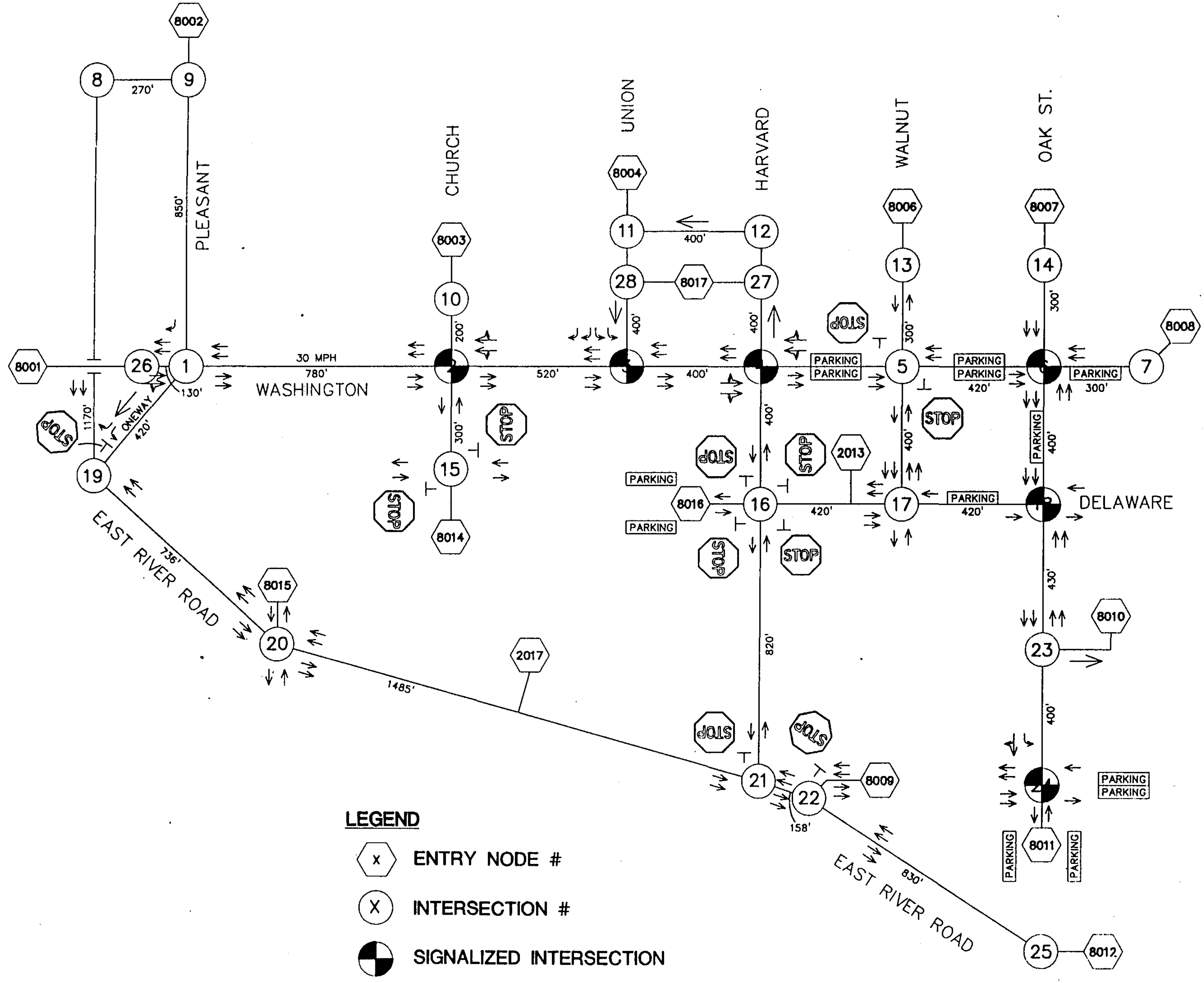


Figure 10

Estimated Daily Level of Service Arterial Streets



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 11
Existing Geometrics
& Traffic Control

The TRAF-NETSIM model was calibrated using the travel time runs conducted during the PM peak period. The results of the analysis are documented in Table 4 and indicate the following:

- Both the travel time runs and TRAF-NETSIM report similar travel speeds and levels of service for Washington Avenue.

- Both methods result in a PM peak hour level of service for Washington Avenue of LOS D.

- The TRAF-NETSIM model accurately represents the existing conditions and can be used as a tool to analyze the impacts of implementing changes to geometrics, volumes, and/or signal phasing.

TRAFFIC IMPACT ANALYSIS OF ALTERNATIVES

The general process used in this impact analysis included the following steps:

- Document change in roadway system (Alternatives)
- Develop New Trip Distribution (Traffic Forecasts)
- Develop New Signal Timing
- Conduct TRAF-NETSIM simulation of each alternative
- Compare alternatives to existing conditions (Traffic Operations Analysis)

ALTERNATIVES

The following alternatives were identified by University staff to be included in this study. Some of the alternatives were discussed at a preliminary level in the University's Campus Master plan and the staff wanted a more detailed analysis to determine the impact of implementing these alternatives.

1.	East River Road Ramp (ERRR) -	Determine the maximum size of the proposed East River Road Replacement Ramp
2.	Full Access at Pleasant Street -	Determine the impact of creating a through intersection on Washington Avenue at Pleasant Street SE with or without the replacement ramp.
3.	Open Church Street -	Determine the impact of opening Church Street north of Washington to through traffic.
4.	Ingress/Egress Options for ERRR -	Given alternative scenarios for the size of the Replacement Ramp and the construction of the proposed new road south of CMU, show the most efficient route(s) of ingress and egress.
5.	Walnut Street -	Test the impact on traffic of making Walnut Street S.E. north of Washington Avenue either a through street or a dead-end primary access route to development sites.

During the study process, several other alternatives were also analyzed:

6. Transit Stop Revisions — Determine the effect of moving the southbound Walnut transit stop to a northbound Harvard location. In addition, determine the effect of moving the stop at Walnut to a location between Harvard and Union.

7. Washington Avenue Corridor — Determine potential improvements to Washington Avenue, including a three-lane roadway with right turn lanes at the major intersections.

TRAFFIC FORECASTS

For each of the alternatives, TranPlan was used to develop the necessary traffic forecasts and trip distribution. Traffic forecasts and trip distribution were generated through the use of the City of Minneapolis' TranPlan traffic model. The Minneapolis model is a parking generated travel demand forecasting tool. Vehicle trips are assigned from parking ramps or lots. The model was used to simulate existing conditions, predict future traffic volumes and develop vehicle distribution for each alternative.

The existing model had the University study area defined as only three zones (Figure 12). In order to produce more detailed results, the model required modifications to refine the transportation network around the University of Minnesota and to add definition to the parking supply zones. The network was refined based on conversations with University staff and is shown in Figure 13. It should be noted that the Minneapolis model is a parking generated model. Therefore, trips are distributed based on the available parking. The trip allocation assigned to the original three zones was redistributed based on the new zone arrangement and is shown in Table 5.

TRAFFIC OPERATIONS ANALYSIS

New signal timing plans were developed for each alternative based on the changes to the existing roadway system and traffic forecast. The timing plans were developed using the Highway Capacity Manual software and PASSER II-90. Cycle lengths and number of phases were kept the same as existing where practical.

For each alternative, the changes to the roadway system, new traffic forecasts, and signal timing were input into the calibrated existing TRAF-NETSIM simulation program. Results of the analysis were documented, including travel time and level of service on Washington Avenue.

Each alternative was compared to the existing conditions to determine the impact of implementation on traffic operations.

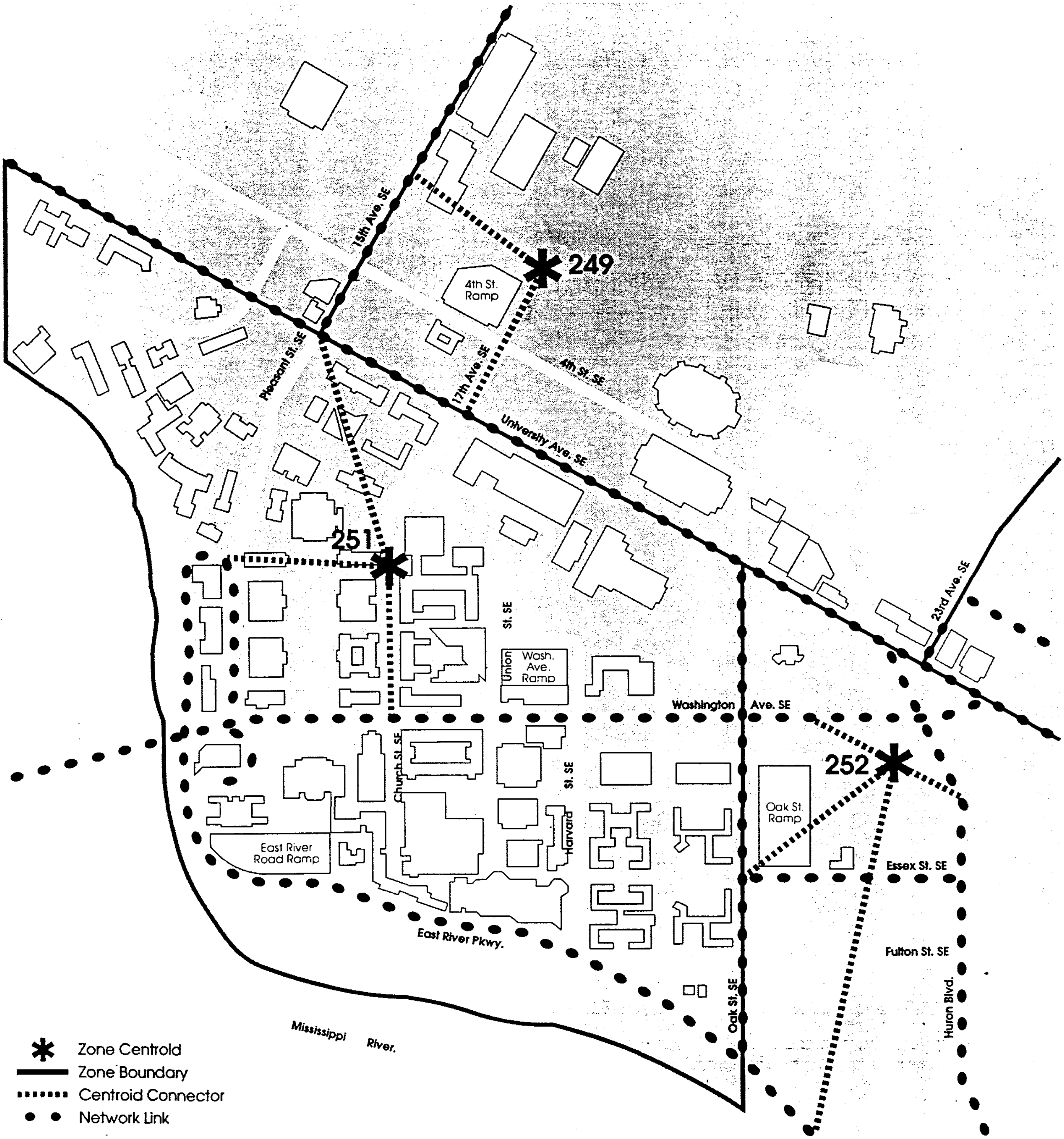


Figure 12

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

March 12, 1997

North 0' 300' 600'

Baseline TranPlan Network
City of Minneapolis

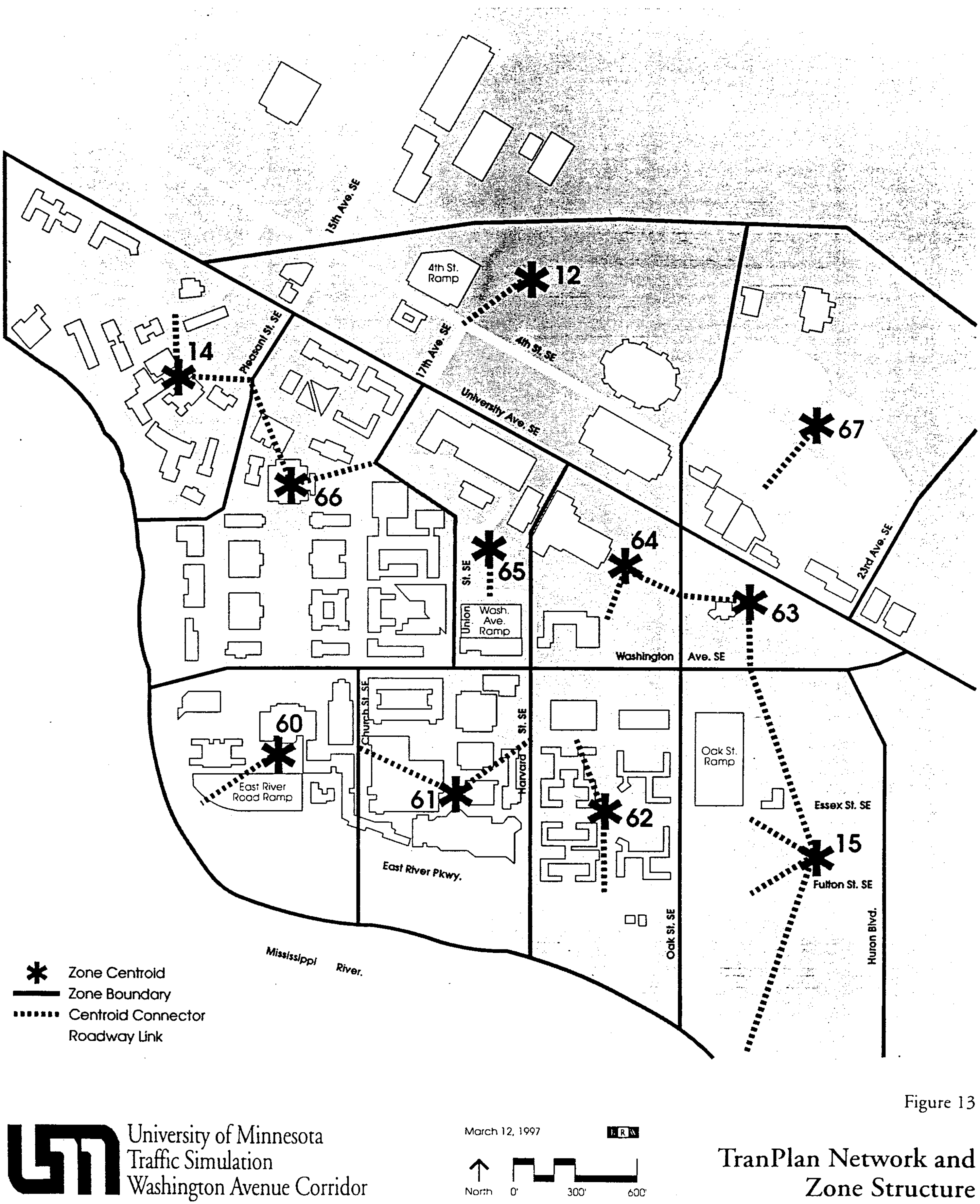


Figure 13

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

TranPlan Network and Zone Structure

TABLE 5
UNIVERSITY OF MINNESOTA SUBAREA TRANPLAN MODEL
PARKING INVENTORY/TRIP END ALLOCATION

- Allocation for Old TAZ 12 and Old TAZ 14 (Combined)

New TAZ	Total Parking	Trip End Allocation
12	2,514	24.7%
14	185	1.8%
60	2,026	19.9%
61	205	2.0%
62	590	5.8%
64	948	9.3%
65	1,319	13.0%
66	585	5.7%
67	1,808	17.8%
Total	**10,180**	**100%**

- Allocation for Old TAZ 15

New TAZ	Total Parking	Trip End Allocation
15	2,174	93.1%
63	160	6.9%
Total	**2,334**	**100%**

ALTERNATIVE ANALYSIS

The following paragraphs provide the results of the analysis of the alternatives described above. Each alternative is described, followed by a description of the process, documentation of the results, and presentation of conclusions.

ALTERNATIVE #1 - East River Road Replacement Ramp

<u>Description</u>

Analyze the impact of increasing the size of the East River Road Replacement Ramp (Figure 14) on the existing road system.

<u>Process</u>

1. Analyze different ramp sizes, varying from the existing 1680 spaces to a maximum of 2500 spaces.

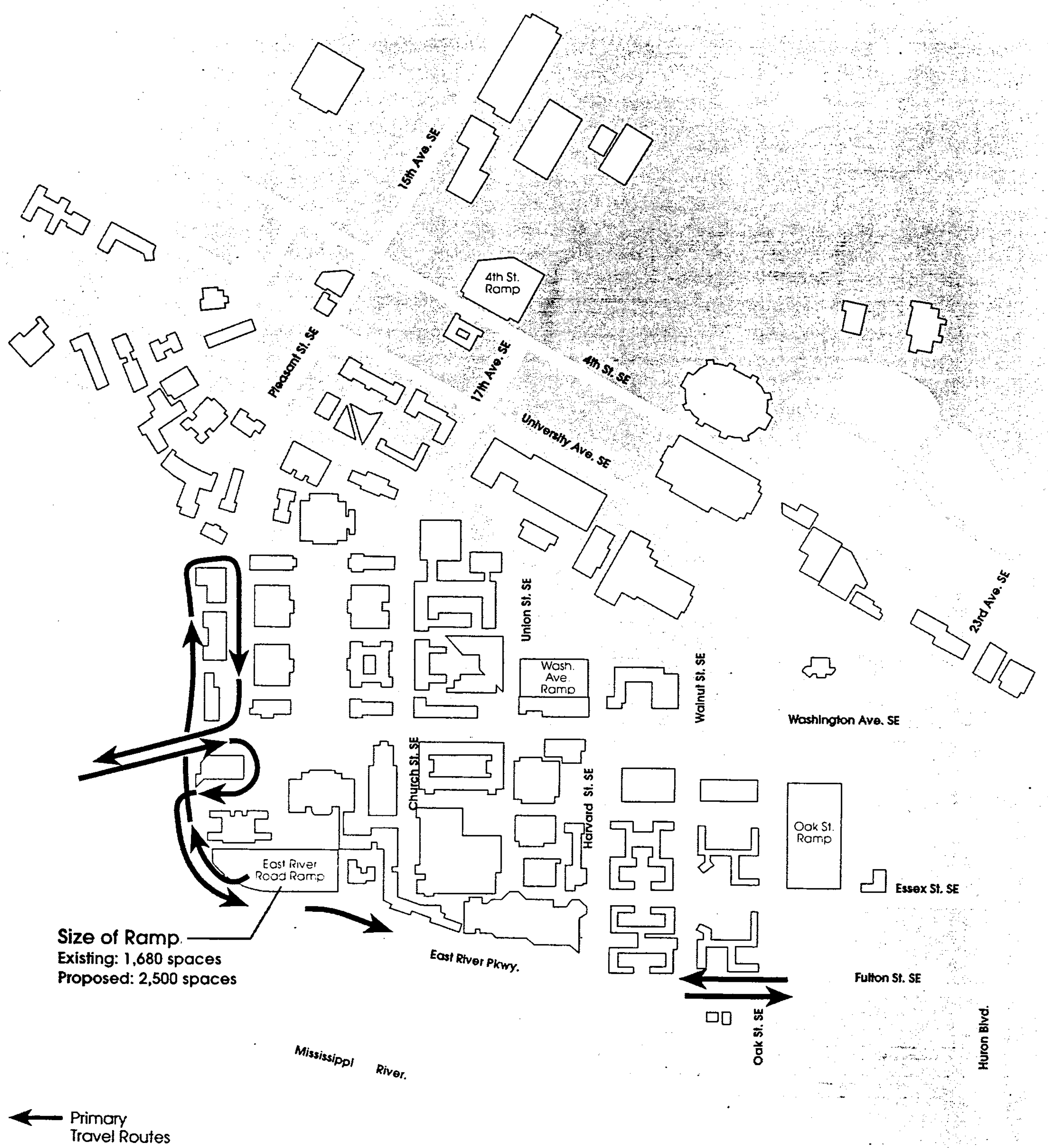
2. Apply the existing ramp trip generation per space to the new size of the Parking Ramp.

3. Increase trip generation in TRAF-NETSIM model to account for larger parking ramp.

<u>Results</u>

1. The primary travel route to and from the ramp from the west is Washington Avenue. Traffic heading to the ramp uses the loop from Washington to East River Road. Traffic heading west from the ramp uses East River Parkway to Arlington and to Pleasant. The major route to the ramp to and from the east would use Oak Street or Huron Boulevard to Fulton Street and East River Parkway.

2. Increasing the size of the parking ramp would not adversely affect traffic operations on Washington because the primary access routes to the ramp do not use Washington Avenue east of Pleasant Street. Therefore, traffic volumes on Washington Avenue would not be expected to increase, regardless of the size of the ramp (Table 6).



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Figure 14

Alternative 1:
Increase Size of East River Road Replacement Ramp

TABLE 6
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
Alternative #1
EAST RIVER ROAD REPLACEMENT RAMP SIZE

DIRECTION OF TRAVEL: West to East

CROSS STREET	LENGTH (FEET)	EXISTING TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EXISTING TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	EXISTING LEVEL OF SERVICE	EAST RIVER RAMP 2000 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2000 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2000 SPACES LEVEL OF SERVICE	EAST RIVER RAMP 2250 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2250 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2250 SPACES LEVEL OF SERVICE	EAST RIVER RAMP 2500 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2500 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2500 SPACES LEVEL OF SERVICE
Pleasant St.													
	780	41.6	12.9	D	41.5	12.8	D	39.5	13.2	C	41.4	12.9	D
Church St													
	520	40.9	8.7	E	41.1	8.6	E	41.3	8.6	E	40.5	8.7	E
Union St													
	400	41.6	6.6	F	45.5	6.0	F	52.4	6.2	F	44.1	6.2	F
Harvard St.													
	420	14.4	19.9	B	14.3	20.0	B	14.2	19.6	B	14.4	19.8	B
Walnut St.													
	420	34.2	8.4	E	34.4	8.3	E	40.2	7.1	E	35.4	8.1	E
Oak St.													
SUBTOTALS	2540	172.7	10.0	D	176.8	9.8	D	187.6	9.2	D	175.8	9.9	D

DIRECTION OF TRAVEL: East to West

CROSS STREET	LENGTH (FEET)	EXISTING TRAF-NETSIM MODEL TIME (Sec)	EXISTING TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	EXISTING LEVEL OF SERVICE	EAST RIVER RAMP 2000 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2000 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2000 SPACES LEVEL OF SERVICE	EAST RIVER RAMP 2250 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2250 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2250 SPACES LEVEL OF SERVICE	EAST RIVER RAMP 2500 SPACES TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EAST RIVER RAMP 2500 SPACES TRAVEL SPEED (MPH)	EAST RIVER RAMP 2500 SPACES LEVEL OF SERVICE
Oak St.													
	420	13.0	21.9	B	13.1	21.7	B	13.1	21.8	B	12.8	22.2	B
Walnut St.													
	420	33.3	8.6	E	36.8	7.8	E	30.1	9.5	D	34.6	8.3	E
Harvard St.													
	400	33.7	8.1	E	32.7	8.3	E	31.6	8.6	E	32.0	8.5	E
Union St.													
	520	39.0	9.0	D	37.4	9.4	D	35.0	10.0	D	36.6	9.6	D
Church St.													
	780	22.9	23.2	B	23.0	23.2	B	23.3	22.9	B	23.2	22.9	B
Pleasant St.													
SUBTOTALS	2540	141.9	12.2	D	143.0	12.1	D	133.1	13.0	C	139.2	12.4	D

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVICE	AVERAGE TRAVEL SPEED (mph)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source: BRW, Inc
R:\3832\LOTUS\ERIVRAMP.WK4

3. The existing daily traffic on the East River Parkway is approximately 4800 vehicles per day. The maximum ramp size of 2500 spaces would result in an increase of 1000 vehicles per day, resulting in daily traffic on East River Parkway of 5800 vehicles per day. East River Parkway is currently operating as a two-lane roadway with a design capacity of 12,500 vehicles per day (See previous Figure 10). Therefore, the increased size of the East River Road Ramp will have no adverse impact on traffic operations on East River Parkway.

4. Increasing the size of the ramp will increase traffic on Arlington and Pleasant Street. The increase in vehicles is still well below the design capacity of Pleasant Street. Currently, there is a large number of pedestrians crossing Pleasant Street between Arlington Street and Washington Avenue and increased conflicts would occur between pedestrians and vehicles.

Conclusions

1. The size of the ramp is not a factor relative to traffic operations on Washington Avenue.

ALTERNATIVE #2 - Full Access Intersection at Pleasant Street SE

Description

Create a full access intersection at Pleasant Street with access to East River Road and the Coffman Union ring road (Figure 15).

Process

1. Analyze the impacts of creating a full access intersection on Washington Avenue in the vicinity of Pleasant Street.

2. Run TRANPLAN to develop the expected traffic distribution.

3. Revise TRAF-NETSIM to model scenario.

Results

1. Based on the expected traffic volumes, the intersection of Washington Avenue and Pleasant Street would require signalization.

2. Results of the TRAF-NETSIM simulation (Table 7) indicates that the impacts of a new intersection on Washington Avenue are minimal, if no connection to the East River Ramp is provided.

3. If a connection is provided to the East River Road Ramp, the increase in traffic is expected to result in poor traffic operations on Washington Avenue.

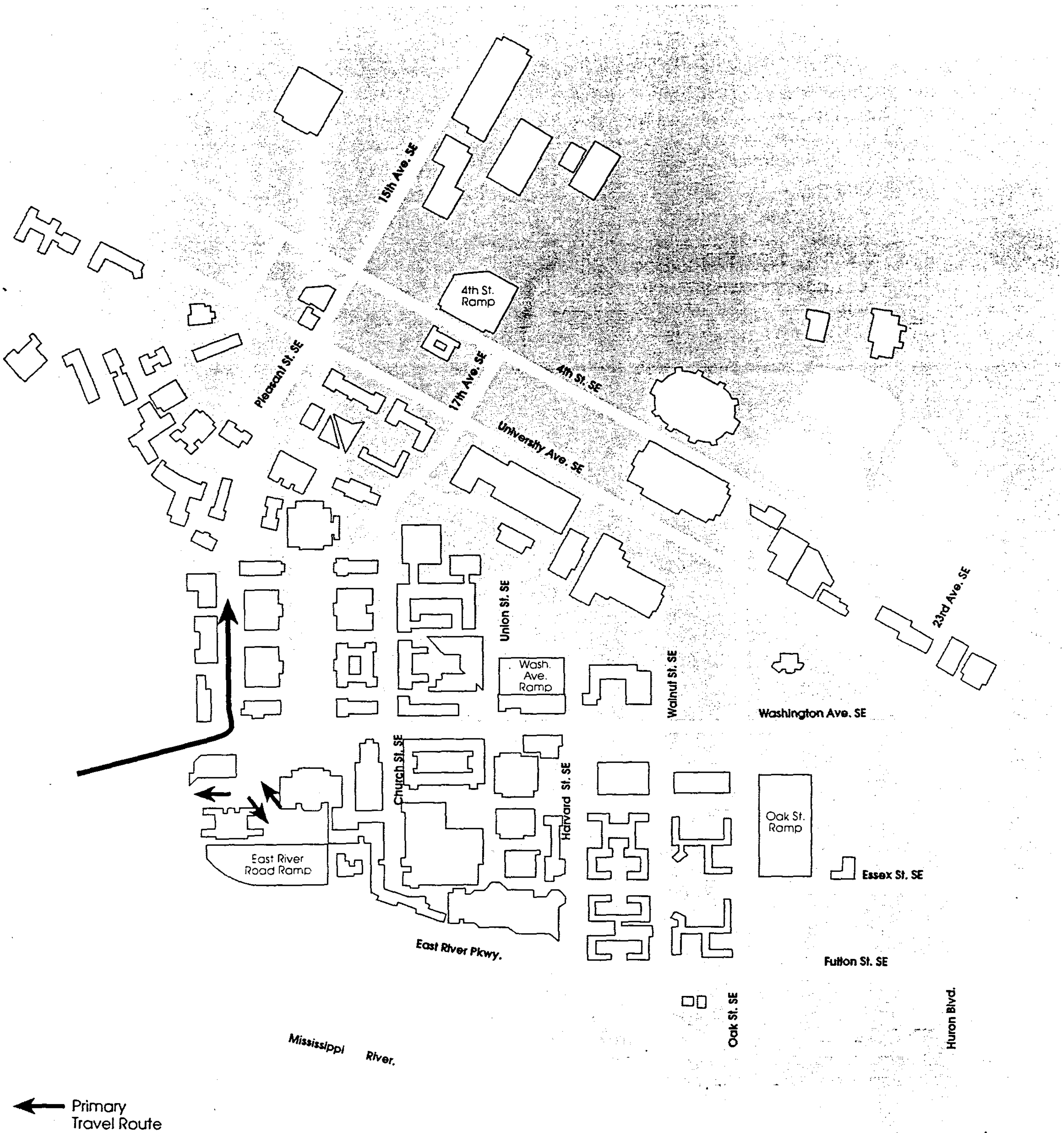


Figure 15

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

March 12, 1997

BRW

North 0' 300' 600'

Alternative 2:
Full Access Intersection at Pleasant Street

TABLE 7
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
Alternative #2
FULL ACCESS INTERSECTION AT PLEASANT

DIRECTION OF TRAVEL: West to East

CROSS STREET	LENGTH (FEET)	EXISTING - OPTIMIZED OFFSETS TRAF-NETSIM MODEL TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	FULL ACCESS AT PLEASANT TRAF-NETSIM MODEL TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
	500	12.4	27.5	A	18.0	18.9	C
Pleasant St.							
	780	41.8	12.7	D	36.9	14.4	C
Church St.							
	520	18.7	19.0	B	19.9	17.8	C
Union St.							
	400	25.7	10.6	D	38.6	7.1	E
Harvard St.							
	420	14.1	20.3	B	14.8	19.3	B
Walnut St.							
	420	34.0	8.4	E	27.6	10.4	D
Oak St.							
SUBTOTALS	3540	146.7	16.5	C	155.8	15.5	C

DIRECTION OF TRAVEL: East to West

CROSS STREET	LENGTH (FEET)	EXISTING TRAF-NETSIM MODEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	FULL ACCESS AT PLEASANT TRAF-NETSIM MODEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.							
	420	13.2	21.6	B	14.5	19.5	B
Walnut St.							
	420	25.6	11.2	D	31.7	9.0	D
Harvard St.							
	400	18.6	14.6	C	23.0	11.9	D
Union St.							
	520	31.0	11.3	D	29.8	11.8	D
Church St.							
	780	22.2	23.9	B	30.1	17.7	C
Pleasant St.							
	500	13.2	25.8	A	13.2	25.8	A
SUBTOTALS	3540	123.8	19.5	B	142.3	17.0	C

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVICE	AVERAGE TRAVEL SPEED (mph)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source: BRW, Inc
R:\3832\LOTUS\PLEASANT.WK4

4. The creation of a full access intersection at Pleasant creates a "short-cut" for vehicles traveling to and from downtown to the University Avenue/ 4th Street one-way pair and parking areas. Vehicles can use Washington Avenue to Pleasant Street The eastbound left turn at Pleasant is expected to be high, approximately 250 vehicles per hour in the PM peak hour.

5. The left turn vehicles would have to turn left out of the inside through lane, causing an unsafe situation. In addition, the left turns are expected to experience long delays.

6. The creation of a full access intersection may not be feasible due to the grades in the area.

7. The grades on Washington are not desirable for the creation of a signalized intersection.

8. Traffic on Pleasant Street would double through the University area.

9. The speed on the Washington Avenue bridge frequently exceeds the posted speed limit of 30 miles per hour.

10. Sight Distance restraints

<u>Conclusions</u>

1. A full access intersection on Washington Avenue at Pleasant Street is not recommended.

ALTERNATIVE #3 - Open Church Street north of Washington Avenue

<u>Description</u>

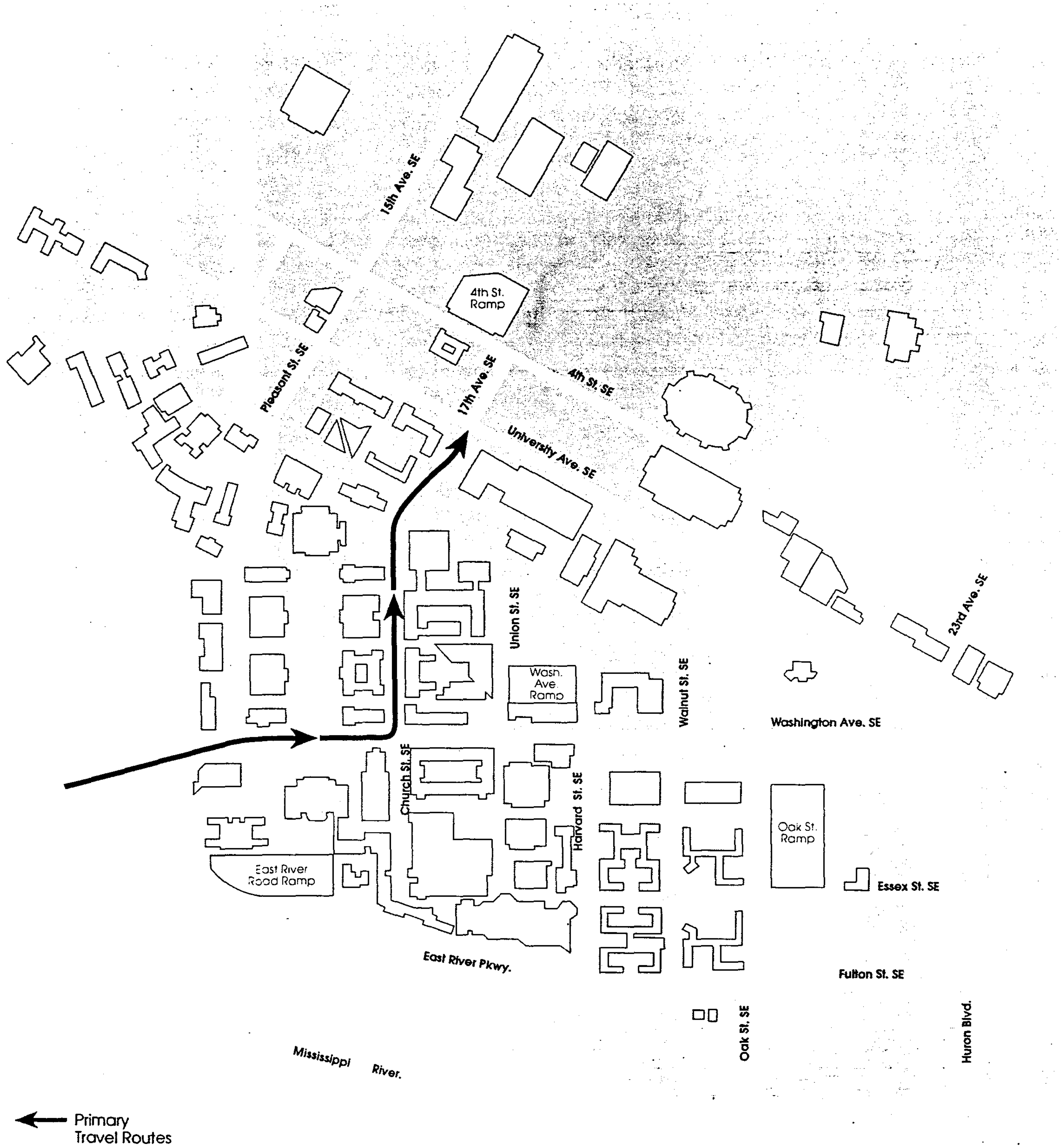
Open Church Street to traffic north of Washington Avenue. Allow left turns from eastbound Washington Avenue to Church Street (Figure 16).

<u>Process</u>

1. Analyze the impacts of opening Church Street to the north of Washington Avenue.

2. Run TRANPLAN to develop the expected traffic distribution.

3. Revise TRAF-NETSIM to model scenario.



University of Minnesota
Traffic Simulation
Washington Avenue Corridor

March 12, 1997

North 0' 300' 600'

Figure 16

Alternative 3:
Open Church Street North of Washington Avenue

Results

1. Opening Church Street to the north of Washington Avenue creates a "short-cut" for vehicles traveling to and from downtown to the University Avenue/4th Street one-way pair and parking areas. The eastbound left turn at Church Street is expected to be high, approximately 250 vehicles per hour in the PM peak hour.

2. The results of the TRAF-NETSIM analysis (Table 8) indicates that traffic operations on Washington Avenue at the Church Street intersection will be adversely impacted. Traffic on Washington Avenue will experience long delays.

3. The eastbound left turns are expected to back up and will experience long delays. The large number of left turns must turn from a through lane, which will act as a defacto left turn lane, limiting the capacity available for the through movement.

Conclusions

1. Church Street north of Washington Avenue should not be opened due to the negative impact on traffic operations.

ALTERNATIVE #4 - Ingress/Egress Alternatives for East River Road Ramp

Description

Determine the best location for ingress and egress to the proposed East River Road Ramp (Figure 17).

Process

1. Compare the existing ingress/egress location (off of East River Parkway) to a new location north of the ramp and south of Coffman Union.

2. The proposed route around Coffman Union would be a two-way road with access to Pleasant Street and Church Street.

Results

1. As noted previously, the current ingress/egress off of East River Parkway minimizes the impact on Washington Avenue while not adversely impacting East River Parkway.

2. Creating an ingress/egress for the East River Ramp south of Coffman Union would adversely impact the operations on Washington Avenue at the Church Street intersection.

TABLE 8
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
Alternative #3
OPEN CHURCH STREET TO THE NORTH

DIRECTION OF TRAVEL: West to East

CROSS STREET	LENGTH (FEET)	EXISTING - OPTIMIZED OFFSETS TRAF-NETSIM MODEL TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	OPEN CHURCH ST TO NORTH TRAF-NETSIM MODEL TRAVEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Pleasant St.							
	780	41.8	12.7	D	280.4	1.9	F
Church St.							
	520	18.7	19.0	B	24.6	14.4	C
Union St.							
	400	25.7	10.6	D	29.1	9.4	D
Harvard St.							
	420	14.1	20.3	B	14.6	19.6	B
Walnut St.							
	420	34.0	8.4	E	29.3	9.8	D
Oak St.							
SUBTOTALS	2540	134.3	12.9	D	378	4.6	F

DIRECTION OF TRAVEL: East to West

CROSS STREET	LENGTH (FEET)	EXISTING TRAF-NETSIM MODEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL TIME (Sec)	TRAVEL SPEED (MPH)	LEVEL OF SERVICE
Oak St.							
	420	13.2	21.6	B	12.6	22.5	B
Walnut St.							
	420	25.6	11.2	D	23.1	12.4	D
Harvard St.							
	400	18.6	14.6	C	19.3	14.2	C
Union St.							
	520	31.0	11.3	D	85.7	4.1	F
Church St.							
	780	22.2	23.9	B	24.2	22.0	B
Pleasant St.							
SUBTOTALS	2540	110.6	15.7	C	164.9	10.5	D

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVIC	AVERAGE TRAVEL SPEED (mph)	
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source BRW Inc
R:\3532\LOTUS\CHURCH.WK4

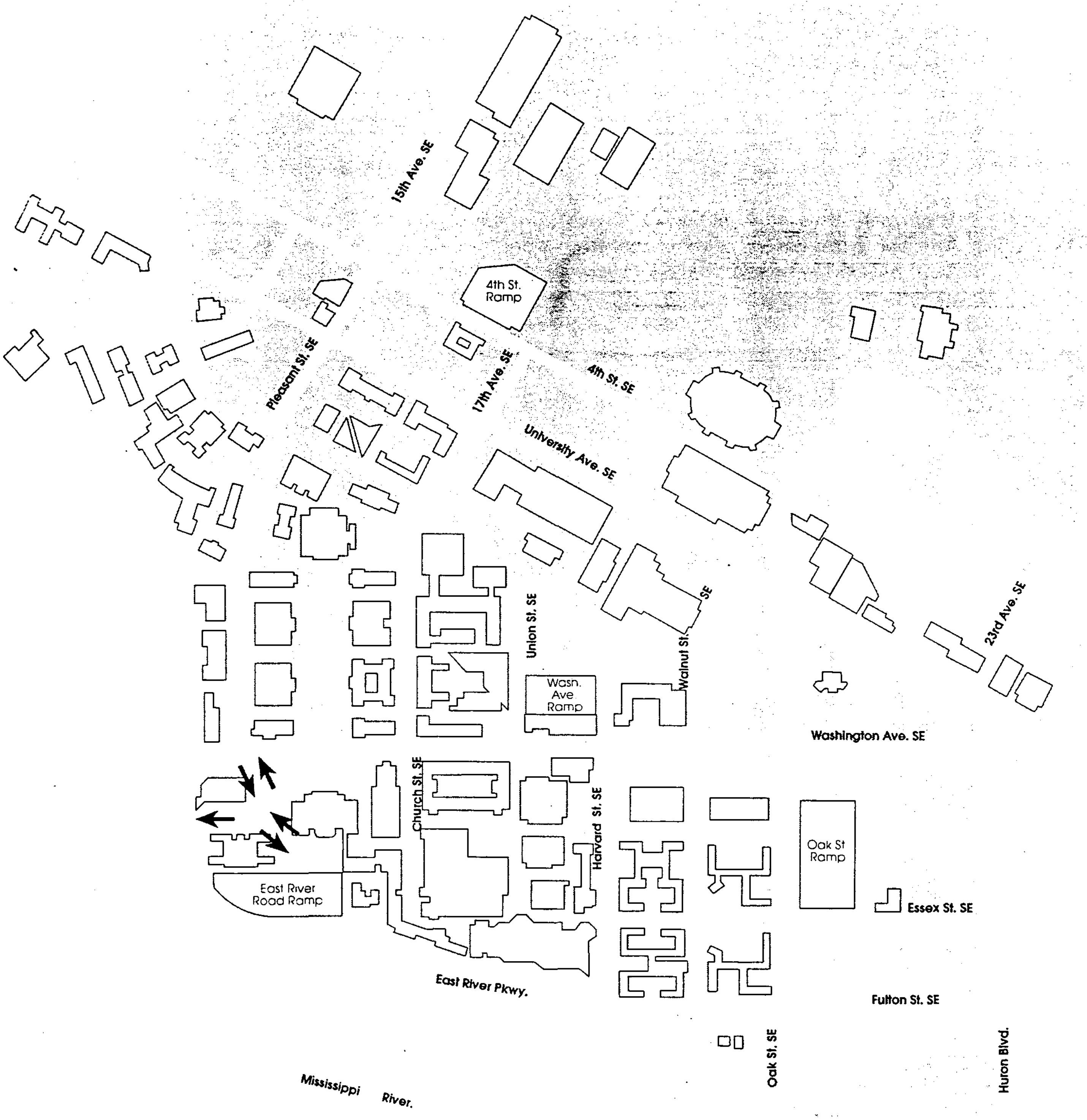


Figure 17

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

Alternative 4:

Ingress/Egress Alternatives for East River Road Ramp

3. If a full access intersection at Pleasant Street was created, a connection for East River Ramp traffic would result in poor traffic operations on Washington Avenue.

Conclusions

1. Based on the traffic operations analysis, the East River Road Ramp should be serviced off of East River Parkway only.

2. Providing access to the ramp facility from Church Street or Pleasant Street is not recommended, due to the impact on traffic operations on Washington Avenue.

3. The number of lanes should take into consideration the size and function (hourly versus contract) of the parking ramp.

ALTERNATIVE #5 - Walnut Street

Description

Analyze the impacts of building a proposed development between Walnut Street and Oak Street north of Washington Avenue (Figure 18).

Process

1. The proposed development calls for 470 parking spaces. The development would result in the removal of approximately 910 parking spaces.

2. Run TRANPLAN to develop the expected traffic distribution.

3. Determine effect on traffic operations.

Results

1. Traffic levels at Walnut Street currently meet the requirements of the Peak Hour Volume Warrant for signalization. Due to the level of traffic and pedestrians in the area, a complete signal warrant analysis should be conducted to determine if the intersection of Washington Avenue and Walnut Street should be signalized.

2. Trips on Washington Avenue are reduced due to fewer parking spaces accessing Walnut Street.

3. Additional parking will need to be provided somewhere to accommodate the parking spaces displaced by the development. The location of a new parking ramp or access to the ramp should be directed away from Washington Avenue and towards Oak Street or the 4th Street/University Avenue one-way pair.

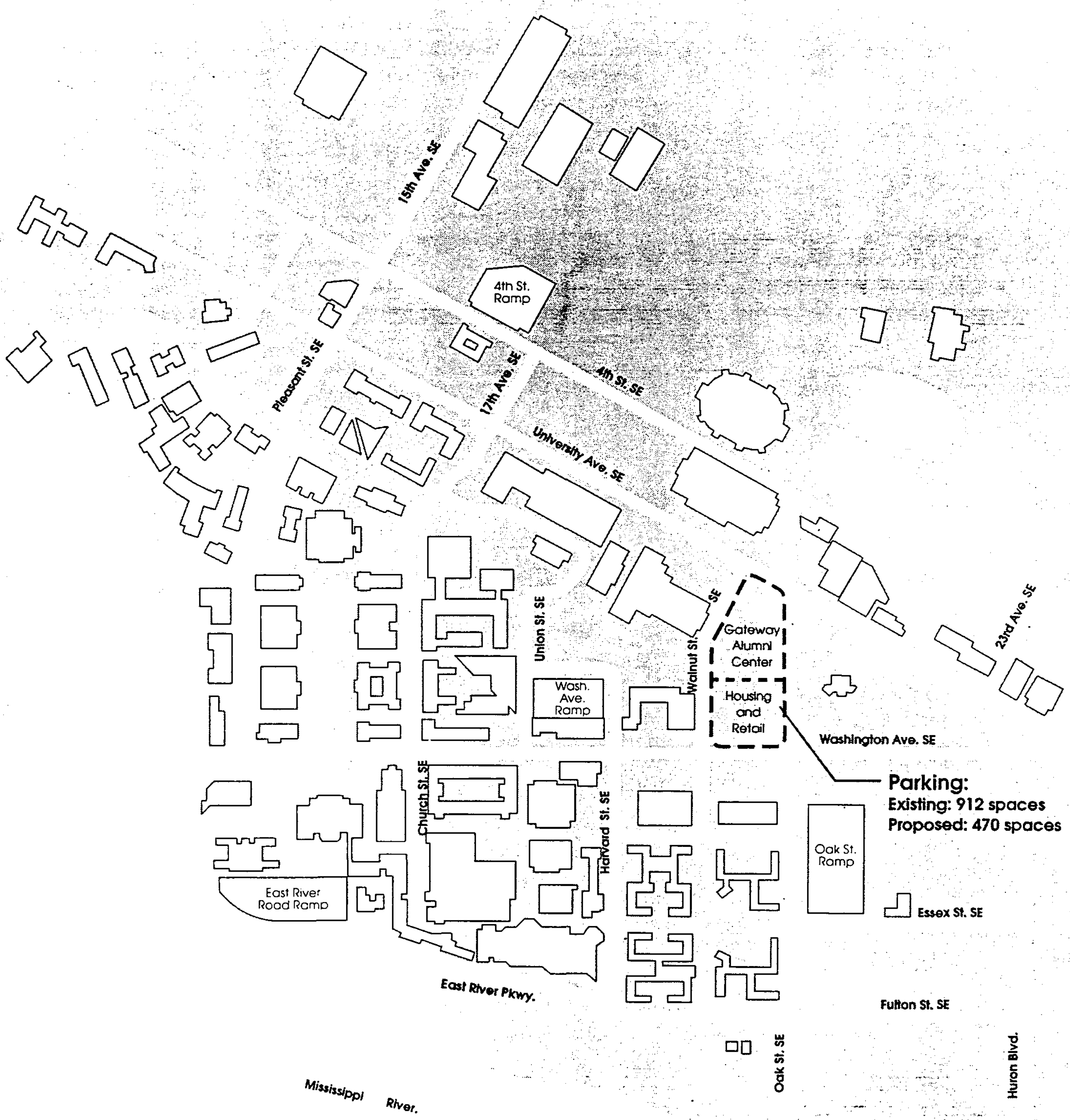


Figure 18

Alternative 5:
Walnut Street

University of Minnesota
Traffic Simulation
Washington Avenue Corridor

March 12, 1997

4. Extending Walnut Street to University Avenue results in an intersection with University Avenue that is too close to the existing signalized intersection of University and Oak. Traffic operations at the two intersections would overlap and may result in queues from Oak Street backing up through the Walnut street intersection.

Conclusions

1. Conduct a signal warrant analysis to determine if the intersection of Washington Avenue and Walnut Street should be signalized.

2. Due to the level of congestion on Washington Avenue, access to the development should be directed away from Washington Avenue. Consideration should be given to providing access off of Oak Street.

ALTERNATIVE #6 - Transit Considerations

Process

Analyze the following changes to the existing transit stop locations (Figure 19):

1. Relocate the transit stop from southbound Walnut just south of Washington Avenue to northbound Harvard just south of Washington.

2. Relocate transit stop on eastbound Washington Avenue from the corner at Walnut to a midblock between Harvard and Union. MCTO stop remains.

3. Analyze current transit stop locations and provide recommendations for consolidation.

Results (Location 1)

1. Both Walnut and Harvard are 30 foot wide roadways. The traffic volume on Harvard is higher than on Walnut.

2. The existing transit stop is just south of Washington on Walnut.

3. The location of this stop could result in traffic backing up onto Washington, because a bus would block the only through lane. There is insufficient room for turning traffic from Washington to pass the bus during its stop.

4. Turning traffic would have limited sight distance to the stopped bus, potentially resulting in safety problems.

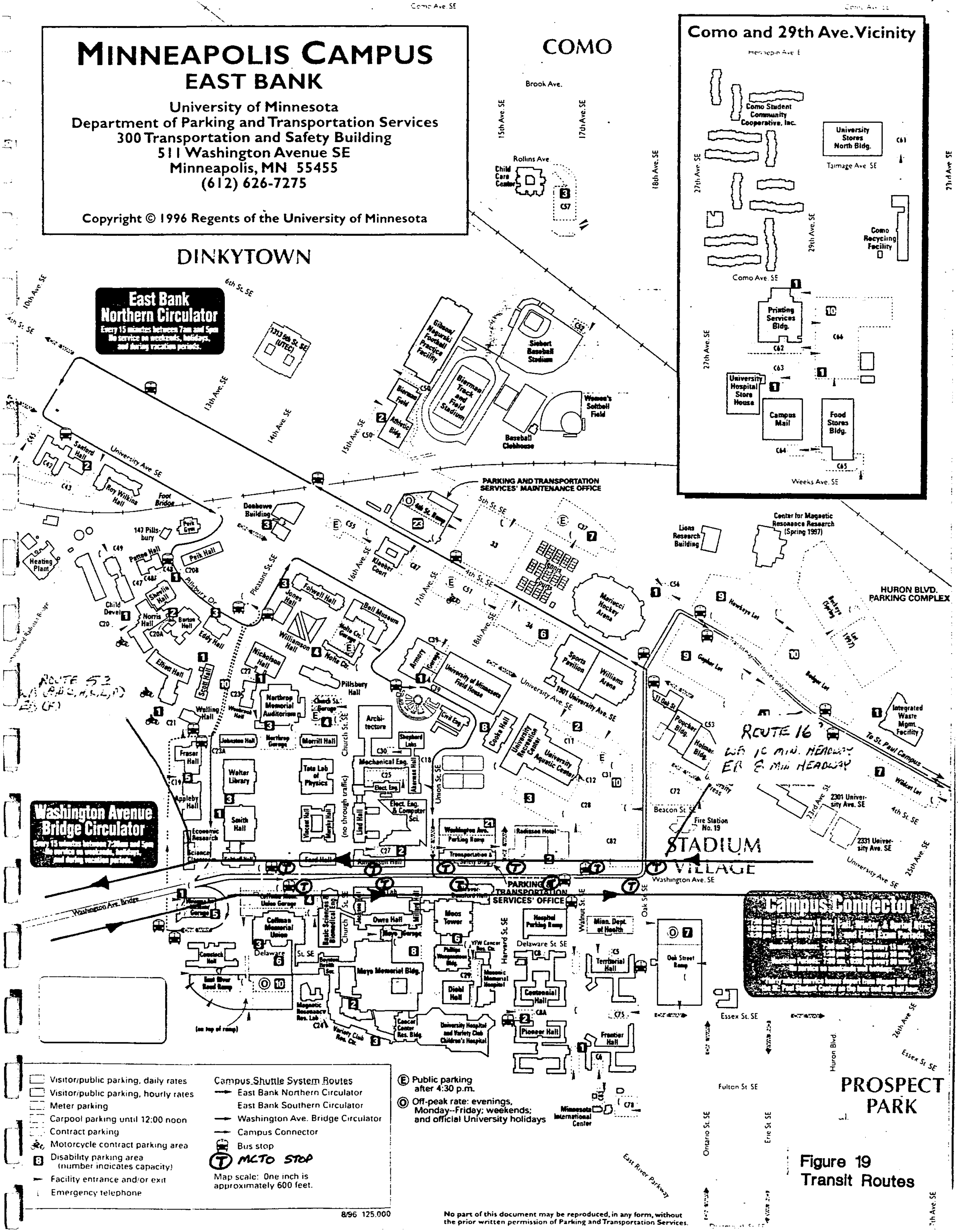


Figure 19
Transit Routes

5. A transit stop on Harvard, northbound just south of Washington Avenue, would require the bus to wait for the traffic signal before continuing on its route. However, the bus is required to pass through this intersection as part of its normal route. Therefore, no increase in delay is expected.

6. There is insufficient room for traffic northbound on Harvard to pass the bus during its stop. If the bus is dwelling at the station during the green phase, vehicles on Harvard would experience increased delay.

7. Traffic northbound on Harvard would have sufficient sight distance to a bus stopped on Harvard.

8. Consideration should be given to the location of the bus stop in relation to the origin/destination of the transit riders.

<u>Results (Location 2)</u>

1. The existing transit stop is in the parking lane on Washington Avenue. Harvard Street is an unsignalized intersection. The transit stop is in front of a service station with a driveway on Washington.

2. The midblock transit stop (between Union and Harvard) occurs in the outside through lane, blocking the through lane during the stop. There is another through lane on Washington Avenue in this area. However, the inside lane is often blocked by the heavy left turn traffic at the Harvard intersection. Therefore, through traffic would face several obstacles on this block.

3. Consideration should be given to the origin/destination of the transit riders in relation to the transit stop.

<u>Conclusions</u>

1. Location 1: The Harvard location is more favorable given the existing roadway geometrics due to safety considerations. If sufficient room is available on Walnut to construct a bus pullout, this location would be the most favorable.

2. Location 2: The transit stop at Walnut is more favorable than the stop at midblock Union/Harvard, because of the heavy left turn movement at Harvard.

3. Consideration should be given to providing bus pullouts where-ever possible.

4. Consolidating the number of transit stops would help improve traffic operations on Washington Avenue. Transit stops on Washington Avenue should be consolidated to three locations:

   1. Coffman Memorial Union, Both Sides
   2. Center for Transportation Studies (South Side); Union Street (North Side)
   3. Oak Street, Both Sides

   The stops should be used jointly by the MCTO and the U of M campus buses and should be designed to accommodate the expected level of vehicles and pedestrians. The design may include bus pullouts similar to what currently exist at Coffman Union.

ALTERNATIVE #7 - Washington Avenue Corridor Improvements

Description

Analyze the impacts of implementing a four-lane divided or three-lane roadway section on Washington Avenue. The three-lane alternative is illustrated in Figure 20.

Process

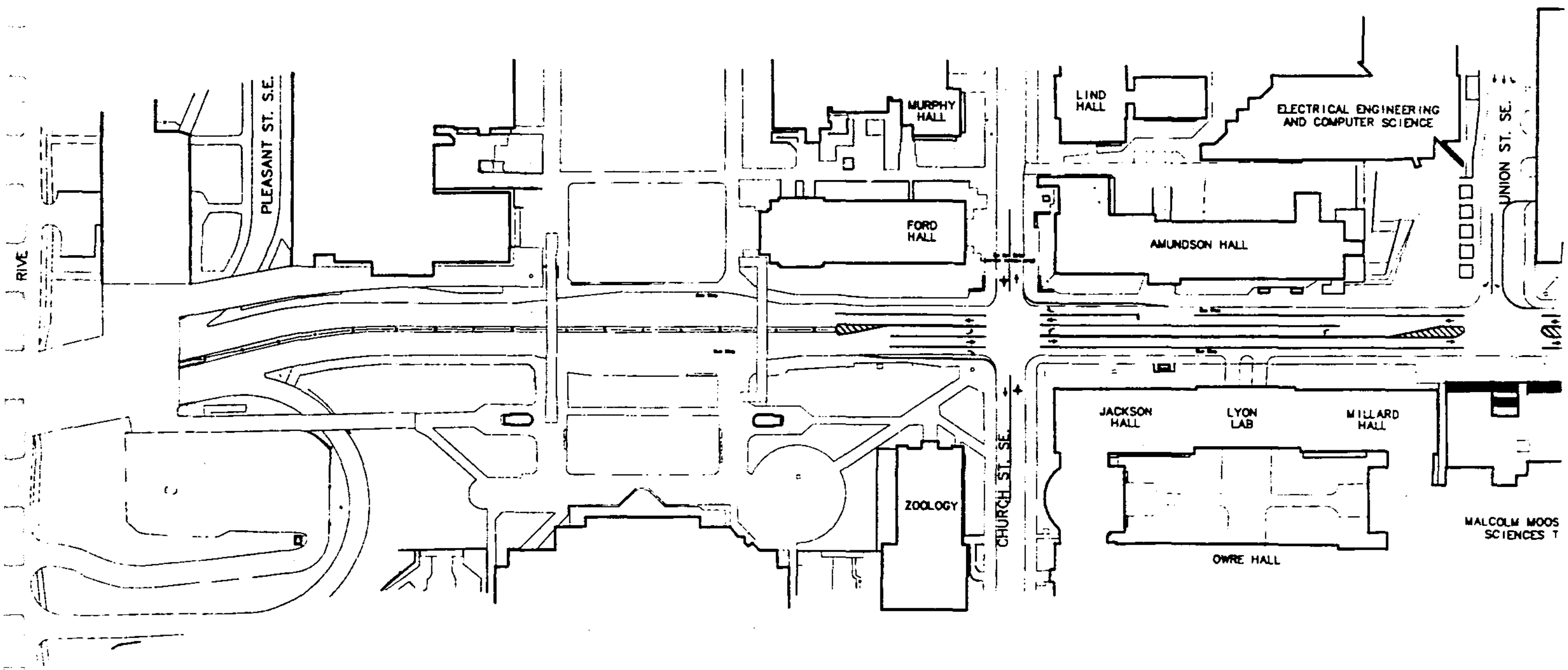
Washington Avenue is currently a minor arterial that also provides access to the University of Minnesota. Conversations with Hennepin County staff indicates that proposed improvements must protect the arterial function of Washington Avenue, and that an alternative would not be acceptable if it did not maintain the current level of traffic operations. Options discussed include a four-lane divided roadway section or a three-lane roadway section.

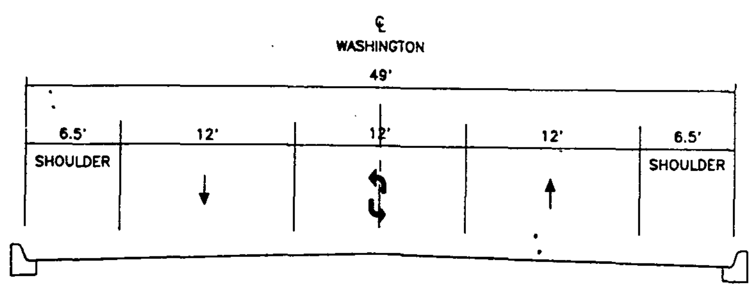
Based on the traffic volumes and the roadway segment capacity graph shown previously in Figure 10, the four-lane divided roadway segment would result in LOS A traffic operations on Washington Avenue. However, land use constraints make this section difficult to implement. The four-lane divided roadway segment would require additional right-of-way and building relocation. Implementation of a four-lane divided roadway alternative is not considered feasible for this corridor.

The three-lane alternative could be implemented with minimal construction impacts. The technical analysis focused on the impacts of implementing the three-lane alternative.

1. Remove parking on Washington Avenue (parking currently exists between Harvard Street and Oak Street).

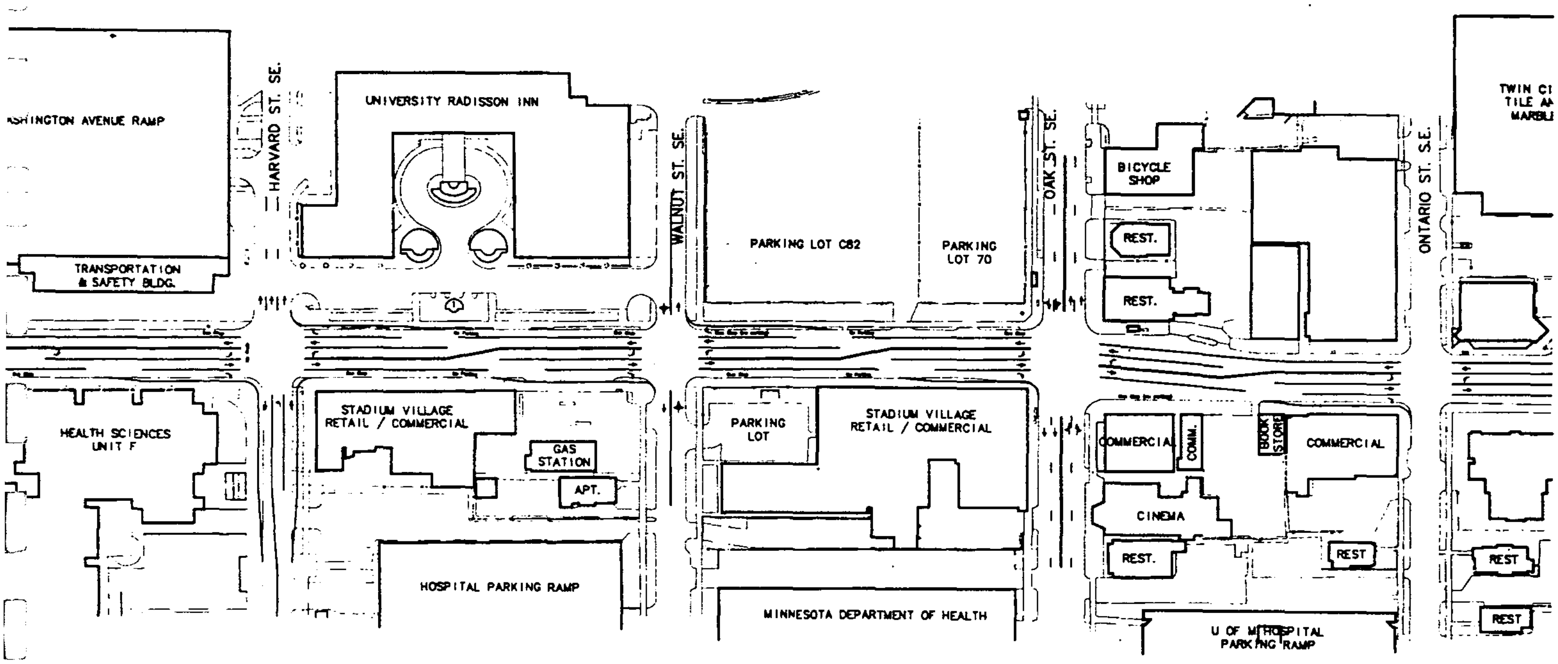
2. Restripe Washington Avenue to provide left turn lanes where needed. The typical section is shown in Figure 21 and would consist of a center left turn lane, one through lane in each direction, and a shoulder.

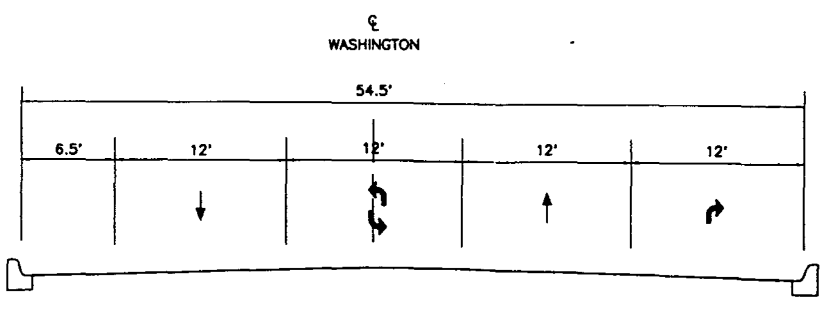




WASHINGTON AVENUE (MIDBLOCK)

University of Minnesota
Traffic Simulation
Washington Avenue Corridor





WASHINGTON AVENUE (APPROACHING INTERSECTION)

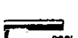
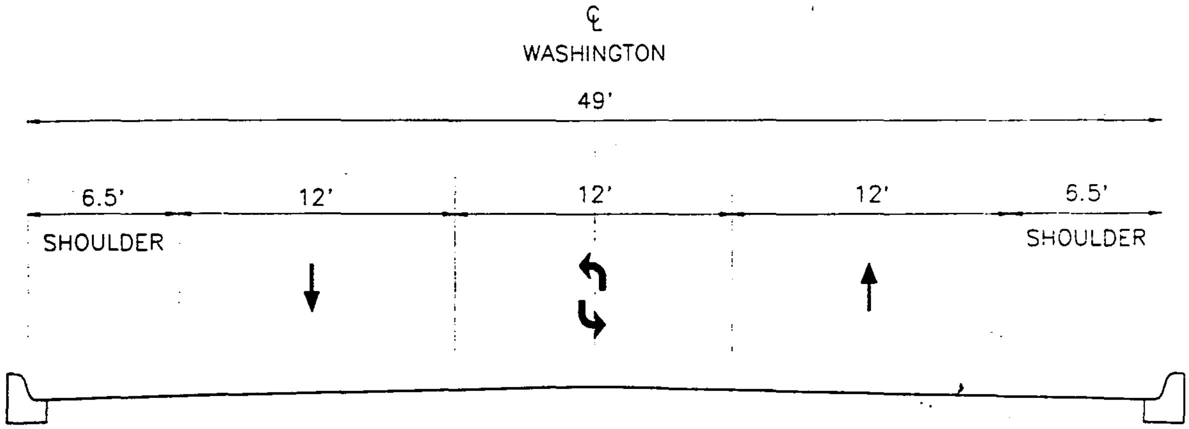
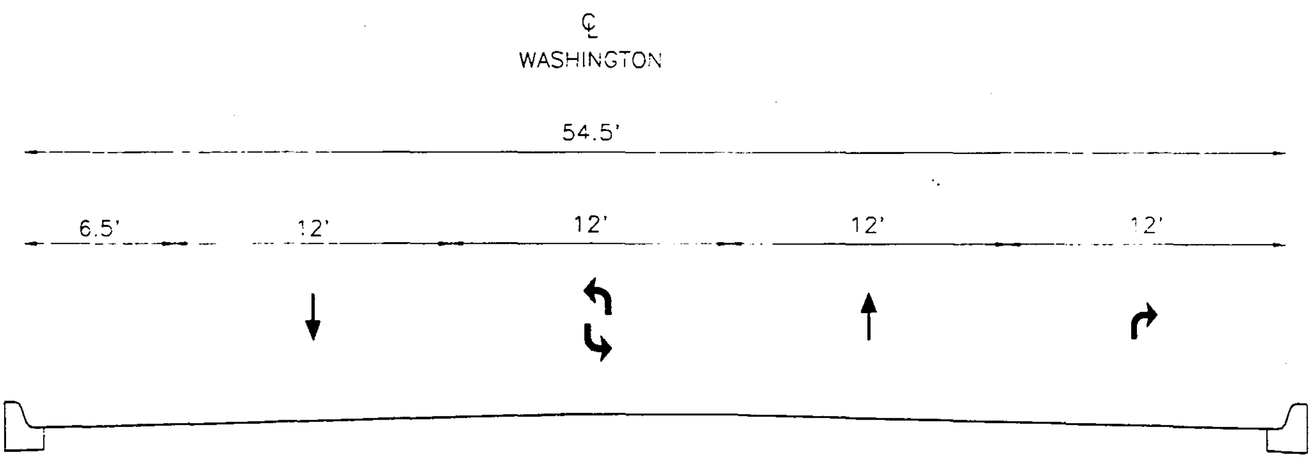


Figure 20
Washington Avenue
3-Lane Alternative



WASHINGTON AVENUE (MIDBLOCK)



WASHINGTON AVENUE (APPROACHING INTERSECTION)

Figure 21
Alternative Typical Sections

3. At each intersection where right turns are allowed, the roadway would be widened to provide for a 100 foot right turn lane. Typically, the widening is approximately 4.5 feet.

4. All bus stops are far side, with the buses stopping in the shoulder area.

5. Harvard Street is widened to provide a northbound left turn lane at Washington Avenue.

6. Signal Cycle Length (100 sec) and Phasing remains the same as existing. The coordinated offset has been adjusted using the TRANSYT-7F program.

<u>**Results**</u>

- Results of the technical analysis indicates that implementation of the three-lane alternative would result in LOS D operations for the Washington Avenue corridor (Table 9). Comparison to existing conditions indicates that the three-lane alternative would produce similar travel speeds in the corridor.

- Results of the technical analysis indicate that the implementation of a three-lane roadway section with right turn lanes at the major intersections would result in similar traffic operations to what currently exists. However, a three-lane roadway section provides several additional advantages:

    1. An exclusive left turn lane is provided at every intersection. Vehicles waiting for a gap in traffic would do so in an exclusive lane, which is considered a safer design when compared to vehicles turning from a through lane.

    2. Exclusive right turn lanes are provided at each intersection. Vehicles waiting for a gap in pedestrian traffic would do so in an exclusive lane, which would not block the through lane.

    3. Transit stop locations would be on the far side of the intersection and would occur in the shoulder area or in bus pullouts.

    4. The three-lane section provides a through lane that is unobstructed by other uses.

<u>**Conclusions**</u>

- Washington Avenue is currently a four-lane undivided roadway. Because of the large number of left turning vehicles, conflicts with pedestrians, conflicts with transit vehicles, and closely spaced access points, the roadway section is congested during large portions of the day. Average travel speeds on the roadway during the AM, Midday, and PM peak periods are approximately 10 miles per hour.

TABLE 9
WASHINGTON AVENUE
PM PEAK PERIOD LEVEL OF SERVICE
Alternative #7
COMPARISON OF EXISTING CONDITIONS TO THREE LANE ALTERNATIVE

DIRECTION OF TRAVEL: West to East

CROSS STREET	LENGTH (FEET)	EXISTING FIELD MEASURED TRAVEL TIME (Sec)	EXISTING FIELD MEASURED TRAVEL SPEED (MPH)	EXISTING FIELD MEASURED LEVEL OF SERVICE	EXISTING TRAF-NETSIM MODEL TRAVEL TIME (Sec)	EXISTING TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	EXISTING TRAF-NETSIM MODEL LEVEL OF SERVICE	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL TRAVEL TIME (Sec)	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL LEVEL OF SERVICE
Pleasant St.										
	780	36.8	14.5	C	41.6	12.9	D	122.9	4.3	F
Church St.										
	520	44.2	8.0	E	40.9	8.7	E	23.5	15.1	C
Union St.										
	400	43.0	6.3	F	41.6	6.6	F	20.4	13.4	C
Harvard St.										
	420	12.8	22.4	B	14.4	19.9	B	13.1	21.8	B
Walnut St.										
	420	32.4	8.8	E	34.2	8.4	E	23.7	12.1	D
Oak St.										
SUBTOTALS	2540	169	10.2	D	172.7	10.0	D	203.6	8 5	E

DIRECTION OF TRAVEL: East to West

CROSS STREET	LENGTH (FEET)	FIELD MEASURED TRAVEL TIME (Sec)	FIELD MEASURED TRAVEL SPEED (MPH)	FIELD MEASURED LEVEL OF SERVICE	EXISTING TRAF-NETSIM MODEL TIME (Sec)	EXISTING TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	EXISTING TRAF-NETSIM MODEL LEVEL OF SERVICE	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL TIME (Sec)	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL TRAVEL SPEED (MPH)	THREE LANE ALTERNATIVE TRAF-NETSIM MODEL LEVEL OF SERVICE
Oak St.										
	420	15.4	18.6	C	13.0	21.9	B	12.8	22.2	B
Walnut St.										
	420	49.0	5.8	F	33.3	8.6	E	28.8	9.9	D
Harvard St.										
	400	40.2	6.8	F	33.7	8.1	E	40.0	6.8	F
Union St.										
	520	44.4	8.0	E	39.0	9.0	D	61.7	5.7	F
Church St.										
	780	21.8	24.4	B	22.9	23.2	B	25.4	20 9	B
Pleasant St.										
SUBTOTALS	2540	171	10 1	D	141.9	12.2	D	168.7	10 3	D

ARTERIAL LEVEL OF SERVICE
(Table 11-1, Highway Capacity Manual)
Free-flow speeds of 35 to 25 mph

LEVEL OF SERVICE		AVERAGE TRAVEL SPEED (mph)
A	>=	25
B	>=	19
C	>=	13
D	>=	9
E	>=	7
F	<	7

Source BRW, Inc
R :3832\LOTUS\COMPARE.WK4

- A four-lane divided roadway section would best address the traffic volumes and access requirements of Washington Avenue. However, the four-lane divided roadway segment would require additional right-of-way and building relocation. Implementation of a four-lane divided roadway alternative is not considered feasible for this corridor.

- Implementation of a three-lane alternative would result in similar travel speeds on Washington Avenue. However, a three-lane roadway section provides several advantages including exclusive lanes for right and left turning vehicles, a shoulder area for bicyclists, an area on the far side of the intersection for transit vehicles to pull out of the through lane. The advantages listed above result in a through lane that is free of obstructions.

- In order to implement the three-lane section on Washington Avenue, the existing on-street parking between Harvard Street and Oak Street parking must be eliminated. However, even if the four-lane undivided roadway section is maintained, eliminating parking would improve traffic operations on Washington Avenue during the non-peak periods.

- Washington Avenue is near capacity with the current roadway section. Increasing capacity on Washington Avenue cannot be accomplished without significant right-of-way and structure acquisition. Therefore, consideration should be given to focusing further development and parking away from Washington Avenue and towards roadways with excess capacity such as East River Parkway, University Avenue and 4th Street one-way pair.

STUDY CONCLUSIONS

- Washington Avenue currently operates as a minor arterial through the University of Minnesota campus serving a significant through movement. However, competing functions conflict with the arterial function and diminish the ability of the roadway to serve the through movement. Because of the large number of left turning vehicles, conflicts with pedestrians, conflicts with transit vehicles, and closely spaced access points, the roadway section is congested during large portions of the day. Average travel speeds on the roadway during the AM, Midday, and PM peak periods are approximately 10 miles per hour.

- In other areas, a potential solution would be to eliminate the competing demands (prohibit pedestrians, reroute transit or provide separate transit lanes, and limit access). However, due to the unique location of Washington Avenue through the U of M campus, these options are not feasible.

- Access to new parking structures or developments along the Washington Avenue corridor should direct traffic away from Washington Avenue as much as possible. When considering the East River Road Replacement Ramp, providing access off of East River Parkway minimizes the impact to traffic operations on Washington Avenue. A new development between Walnut and Oak Street should provide access off of Oak Street to minimize the impact of turning vehicles on Washington Avenue.

- As part of this study, alternatives were analyzed that would provide additional access from Washington Avenue to the campus north of Washington at Pleasant Street and/or Church Street. The results of the technical analysis indicates that providing access at either of these locations would have a significant negative impact on traffic operations along Washington Avenue. With respect to traffic operations, no additional access should be considered from Washington Avenue.

- Consolidating the number of transit stops would help improve traffic operations on Washington Avenue. Transit stops on Washington Avenue should be consolidated to three locations:

    1. Coffman Memorial Union, Both Sides
    2. Center for Transportation Studies (South Side); Union Street (North Side)
    3. Oak Street, Both Sides

The stops should be used jointly by the MCTO and the U of M campus buses and should be designed to accommodate the expected level of vehicles and pedestrians. The design may include bus pullouts similar to what currently exist at Coffman Union.

- Signalizing the intersection of Walnut Street and Washington Avenue may be appropriate, since the volumes meet the peak hour volume requirements. A complete warrant analysis should be conducted to determine if signalization of the intersection is appropriate.

- A four-lane divided roadway section would best address the traffic volumes and access requirements of Washington Avenue. However, the four-lane divided roadway segment would require additional right-of-way and possibly building relocation. Implementation of a four-lane divided roadway alternative is not considered feasible for this corridor.

- The simulation model indicates that implementation of a three-lane alternative would result in similar travel speeds on Washington Avenue. However, a three-lane roadway section provides several advantages including exclusive lanes for right and left turning vehicles, a shoulder area for bicyclists, an area on the far side of the intersection for transit vehicles to pull out of the through lane. The design features associated with a three-lane roadway would result in a through lane that is free of obstructions.

- In order to implement the three-lane section on Washington Avenue, the existing on-street parking between Harvard Street and Oak Street parking must be eliminated. However, even if the four-lane undivided roadway section is maintained, eliminating parking would improve traffic operations on Washington Avenue during the non-peak periods.

- Washington Avenue is near capacity with the current roadway section. Increasing capacity on Washington Avenue cannot be accomplished without significant right-of-way acquisition. Therefore, consideration should be given to focusing further development and parking away from Washington Avenue and towards roadways with excess capacity such as East River Parkway, University Avenue and 4th Street one-way pair.